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ORIGINAL ARTICLES.

I. — Devonian Fossils from Devonshire.

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1. Coblenzian Fossils from Lynton.

(PLATE XVII.)

THE specimens described below were collected by my friend Mr. J. G. Hamling, F.G.S., and kindly placed by him in my hands for description. Being casts and often much obscured by injury and distortion, their identification must be in a degree problematical, but for the most part they seem to agree with German species of the Upper Coblenzien age.

Bellerophon, sp.

A slab with several poor casts comes from the "Cliff path, W. of Woodabay." They appear high with rounded back.

Pterinea fasciculata, Goldfuss, sp. (Pl. XVII, Figs. 1, 2.)

1834–40.	*Pterinea fasciculata*,	Goldfuss:	Petref. Germ., vol. ii, p. 137, pl. cxxix, fig. 5.
1853.	,,	,,	Sandberger: Verst. Rhein. Nassau, p. 293, pl. xxx, fig. 7.
1885.	,,	,,	Follman: Devon Aviculaceæ, p. 187, pl. iii, fig. 3.
1889.	,,	,,	Kayser: Abh. k.p. Geol. Landes., n.s., pt. i, p. 20, pl. vii, fig. 11.
1891.	,,	,,	Frech: Abh. Geol. Specialk. Preuss., vol. ix, pt. 3, p. 84, pl. viii, fig. 1; pl. ix, fig. 1.

Left valve convex, somewhat produced at the postero-inferior margin. Front wing large, rounded, not truncated in front. Hind wing large, long, rather narrow, sigmoid behind. Surface having on the body six or seven strong, high, nodulate, distant ribs, with flat interspaces each of which bears five or six minute irregular minor ribs; on the front wing, three or four closer and more confluent ribs; and on the hind wing, ten or twelve small close ribs; the whole being crossed by very numerous, minute, regular, crenulated growth-lines. Hinge with four strong, irregularly horizontal teeth in front of the umbo, below which is a small deep muscle-mark. Hind teeth unseen in English specimens.

Size: length 45 mm., height 30 mm.

Eight specimens from "Woodabay, above Pier," "Quarry in road above Crock Point, Woodabay," and "Cutting under Railway N. of Barhrick Mill, Lynton."

Upper (and Lower) Coblenzien.

ACTINOPTERIA, sp.

From the "East side of Lee Bay, Lynton," are two very fragmentary specimens of an oblique *Avicula*, with rather fine alternating striæ (in one finer than in the other). They are exceedingly like some of the *Actinopteriæ* from the Barton Beds and from the Upper Devonian of Germany, but they do not admit of identification.

MODIOMORPHA LAMELLOSA, Sandberger, sp. (Pl. XVII, Figs. 3, 4.)

1895. *Modiomorpha lamellosa*, Beushausen: Abh. k.p. Geol. Landes., N.S., pt. xvii, p. 18, pl. i, figs. 19–21.

Cast very oblique, transverse, almond-shaped, obliquely depressed down the centre. Umbo situate at about the anterior fifth of the length. Anterior end narrow, rounded. Anterior muscle-mark large, prominent, terminal. An oblique triangular tooth under the umbo of the right valve, and two or three long transverse striations on the arching hinge-line behind.

Size: about 60 mm. long and 30 mm. high.

There are six specimens from the "East side of Lee Bay, Lynton." They seem chiefly to differ from Sandberger's and Beushausen's figures in being rather narrower and more produced at the anterior end, and are probably no more than a variety. The internal arrangements agree exactly with Kayser's figure of *Modiomorpha bilsteinensis*, Beushausen (Jahrb. k.p. Geol. Landes. für 1894, p. 127, pl. iii, figs. 4–6), a much shorter and more oval species.

Upper Coblenzien.

NUCULA LODANENSIS, Beushausen. (Pl. XVII, Fig. 5.)

1895. *Nucula Lodanensis*, Beushausen: Abh. k.p. Geol. Landes., N.S., pt. xvii, p. 48, pl. iv, figs. 6, 7; 14?

From the "Cutting under Railway N. of Barhrick Hill, Lynton," is the cast of a *Nucula*, which appears almost exactly to agree with Beushausen's species. Our figure does not give a very clear idea of its real shape, the back of the cast having been sheared off, and thus lessening its apparent height. It was evidently thick-shelled and deep; there are signs of a few strong teeth; its umbo is somewhat to the rear, and bends slightly forward; its posterior end is rounded, its anterior end narrow and subangular, and its lower margin decidedly curved; its posterior muscle-mark is large and faint, and its anterior deep and occupying the upper half of the anterior end.

Size: 14 mm. long, 9 mm. high.

This shell is larger and rounder than *N. Krachtæ*, F. A. Römer, to

which M'Coy appears to have referred it, and very much smaller than *Lima Neptuni*, Giebel, which is referred to *Nucula* by Kayser.

Upper Coblenzien.

PANENKA RIGIDA, F. A. Römer, sp.

1866. *Cardium rigidum*, F. A. Römer: Betr. Harzgeb., pt. v, p. 10, pl. iii, fig. 1.
1879. *Cardiola ? rigida*, Kayser: Abh. Geol. Specialk. Preuss., vol. vi, pt. 1, p. 122, pl. xviii, figs. 2, 3.

A specimen from "Heddon's Mouth (new road)" evidently belongs to this magnificent species. It is a blurred cast in bluish micaceous schistose grit, retaining the surface-ornament round the margins and showing the inner line of the shell beneath the umbo. Its size and marginal contour exactly agree with the German figures. Its ribs, while slightly more numerous than those of the figured specimens, are no more than the number mentioned in Kayser's description.

Size: 80 mm. long, 67 mm. high.

Unter Wieder Schiefer (below Haupt Quarzit).

SPIRIFERA DALEIDENSIS, Steininger. (Pl. XVII, Fig. 6.)

1840. *Spirifera aperturata*, Phillips: Pal. Foss., p. 77, pl. xxx, fig. 133.
1864. ,, *canalifera*, Davidson: Brit. Foss. Brach., vol. iii, p. 26.
1889. ,, *Daleidensis*, Kayser: Abh. k.p. Geol. Landes., N.S., vol. i, pp. 27, 84, pl. i, figs. 5, 6; pl. x, fig. 11.

A dorsal valve from "East side of Lee Bay, Lynton," appears to agree with the species defined by Kayser, though it is so crushed and defective that little of its character remains. It seems to have been somewhat wider than long, with a strong elevated fold having at least three ribs, which perhaps divaricate in front in the manner of that species, and with nine strong ribs on each wing.

This is no doubt the same as Phillips' shell, for which Davidson had found a still earlier name than Schlotheim's, but which Kayser (1878, Abh. Geol. Specialk. Preuss., vol. ii, pt. 4, p. 174, note) considered more probably to belong to *S. Daleidensis* than to the species to which Phillips had referred it. Phillips' figure shows four ribs on the fold.

Upper Coblenzien.

SPIRIFERA PARADOXA, Schlotheim, sp. (Pl. XVII, Fig. 7.)

1853. *Spirifer paradoxus*, Schnur: Palæontogr., vol. iii, p. 198, pl. xxxii *b*, fig. 1.
1889. ,, ,, Kayser: Abh. k.p. Geol. Landes., N.S., vol. i, p. 28, pl. ii, figs. 6, 7.

Nine specimens from "Quarry on road above Crock Point, Woodabay," appear to belong to an extremely transverse variety of this species, being more like those quoted above than are most of the numerous figures given of it by various authors. The central fold is large and probably prominent, the flatness seen in our figured specimen having been most likely caused by pressure. The lateral ribs are small, visible almost to the angles, and almost 50 in number. The wings appear to be acute and alate at their extremities.

Size: about 15 mm. long and 75 mm. wide.

Upper Coblenzien.

ORTHOTETES HIPPONYX, Schnur, sp. (Pl. XVII, Fig. 8.)

1878. *Streptorhynchus Devonicus*, Kayser: Abh. Geol. Specialk. Preuss., vol. ii, pt. 4, p. 199, pl. xxix, figs. 3, 4.

1897. *Orthotetes hipponyx*, Œhlert: Bull. Soc. Géol. Fr., ser. III, vol. xxiv, p. 856, pl. xxvii, figs. 9–11.

Numerous specimens of a shell akin to *O. umbraculum* come from the "Cutting under Railway N. of Barhrick Mill, Lynton." They appear to belong to a widespread Lower Devonian species, to which Œhlert, rejecting D'Orbigny's name *Devonicus*, has applied the one which Schnur had first adopted, but afterwards dropped upon wrongly identifying his shell with Vanuxem's.

Œhlert gives various distinguishing characters which, even in the imperfect condition of our shells, seem to hold good, except that ours are not of so large a size. Our shells are remarkable for the very great size and irregularity of the hinge-area of the ventral valve. This sometimes appears triangular in shape and higher than its length, and sometimes irregular in shape but still high. The rest of the shell seems little affected by this contortion of the umbo. The hinge-line, though sometimes auriculate, is not generally equal to the greatest width of the valve. It seems also to differ from *O. umbraculum* by being more circular, by the method of increase of its ribs, by not being roughened by the existence of dense transverse striations, and by other particulars.

It is rather curious that this irregular shape and great size of the hinge-area should be so pronounced in a Lower Devonian form, when it does not appear in higher Devonian zones, but becomes again exceedingly noticeable in Carboniferous varieties of *O. crenistria*, as witness Davidson's plates.

Our figure, unfortunately, does not show the distinguishing characters of the shell, which I did not realize until after it had been drawn.

Goblenzien.

ORTHIS LONGISULCATA, Phillips. (Pl. XVII, Fig. 9.)

1840. *Orthis longisulcata*, Phillips: Pal. Foss., p. 62, pl. xxvi, fig. 105.

From the "Cutting under Railway N. of Barhrick Mill, Lynton," and "Woodabay, above Pier," are several specimens of a rather large *Orthis*. It has a transversely oval form, rather elevated umbo and short hinge-line, and is covered with very fine divaricating striæ, which arch outwards on the shoulders. Its muscular area is large.

This appears to be the species described by Phillips, though his drawing is rather smaller. It was doubtfully united by Davidson to *O. arcuata*, Ph., from Hope's Nose, from which, I think, it is really quite distinct. It bears much resemblance to the shell figured by Kayser and Œhlert as *Orthis palliata*, Barrande, but our shells present no evidence of a double hinge-line.

PHYLLOPORA ASPERA, Ulrich?

1890. *Phyllopora aspera*, Ulrich: Geol. Surv. Illin., vol. viii, p. 613, pl. xliv, fig. 5.

Specimens from the "Road Section above Watersmeet" and the "Quarry in road above Crock Point, Woodabay," show little to

separate them from this American species. Possibly the fenestrules may be arranged in rather more regular lines and in some parts the cells may be rather more numerous, but this seems only accidental.

Upper Helderberg Beds.

FENESTELLA, sp.

Several fragmentary specimens come from the "Quarry in road above Crock Point, Woodabay," but they are quite unrecognizable.

2. LOWER DEVONIAN FOSSILS FROM TORQUAY.

(PLATE XVIII.)

It is not often that a Museum can supply its shelves with specimens dug from its actual site. Such, however, was the case with the Torquay Natural History Society, when, in digging the foundation of the "Pengelly Memorial" Hall, which it added to its Museum in 1894, a rich fossiliferous bed, 4 feet thick, was found in the soft slates on which that building stands. Hundreds of fossils were carefully collected from it by the Curator, the late Mr. Else, and by the kindness of the Society I have been permitted to attempt their description below. The fossils are entirely moulds or casts, and have suffered very greatly from squeezing and distortion, but in some cases minute structure is beautifully preserved. It will be seen that they may on the whole be referred to the Upper Coblenzien, or to a slightly higher horizon. The richness of the band is in striking contrast to the general barrenness of the adjoining strata.

Mr. A. Somervail, F.G.S., Secretary to the Society, thus writes of the position of the slates:—"A slight examination of the structure of the Torwood Valley would at once reveal the relations of the slates to the adjoining rocks. The valley runs in a nearly E.N.E. and W.S.W. direction, lying between the long ridges of the Lincombe and Warberry Hills. The valley at its commencement on its S.W. side traverses limestones, and a little in its N.E. course the slates at the Museum, which pass below the limestones. Still further on in the same direction another series of slates and grits, forming the Lincombe and Warberry ridges, in their turn pass below the slates exposed at the Museum; so that, as we ascend the Torwood Valley from the Strand, we walk over rocks in a descending sequence, the highest being the limestones, the lowest the Lincombe and Warberry grits, the fossiliferous slates at the Museum holding an intermediate position."

PHACOPS SCHLOTHEIMI, Bronn, sp.?

1825. *Calymene Schlotheimi*, Bronn: Leonhard's Zeitsch., pt. i, p. 319, pl. ii, figs. 5–8.
1876. *Phacops latifrons*, F. Römer: Leth. Palæoz., pt. i, pl. xxxi, fig. 2.
1884. ,, *Schlotheimi*, Kayser: Jahrb. k.p. Geol. Landes., 1883, p. 35.
1897. ,, ,, Kayser: Zeitsch. Deutsch. Geol. Gesell., p. 285.

The head of a small trilobite occurs, which is too much covered with matrix for certain identification. What can be seen of it, however, points to its belonging to the small common form from

the Eifel, which Bronn, and afterwards independently Kayser, separated from *Ph. latifrons*. The eyes are large and level with the top of the glabella, which overhangs the strong marginal rim of the front. There are eight lenses in the vertical rows of the eye. Though it is a cast, indications remain that the glabella was as roughly tuberculate as in Römer's figure, which Kayser refers to this species.

Calceola-schists and Eifelkalk.

ORTHOCERAS, sp.

The cast, probably, but not certainly, of a body-chamber, shows a central siphuncular opening. It is widely oval in section, but has been somewhat squeezed. It might possibly belong to *O. ellipticum*, Münster.

ORTHOCERAS HERCYNICUM, Kayser?

1879. *Orthoceras hercynicum*, Kayser: Abh. Geol. Specialk. Preuss., vol. ii, pt. 4, p. 72, pl. x, figs. 7, 8, 11.

Another cast appears to approach, or to belong to, this species. Its section is oval, with diameters of 21 mm. and 18 mm., and the siphuncle is situated on the longer diameter, nearly half-way from the centre. The chambers are about four times as wide as high, and are very obliquely placed.

Haupt Quarzit.

CAPULUS PRISCUS, Goldfuss? (Pl. XVIII, Fig. 1.)

? 1878. *Capulus priscus*, Kayser: Abh. Geol. Specialk. Preuss., vol. ii, pt. 4, p. 94, pl. xvi, fig. 5; pl. xx, figs. 11, 14, 15.

A flattened cast may perhaps belong to Goldfuss's species, but it does not retain sufficient character to admit of certainty. All that can be said is that what remains of the fossil agrees with it, and that the curvature of the apex and the rate of increase of the whorl are the same. A few spots on the cast may perhaps indicate the tubercles of that shell; but they are far too indistinct to be relied on, and may be entirely accidental marks.

Upper Coblenzien and Eifelkalk.

CONOCARDIUM cf. CUNEATUM, F. A. Römer, sp.

? 1895. *Conocardium cuneatum*, Beushausen: Abh. k.p. Geol. Landes., n.s., pt. xvii, p. 407, pl. xxx, figs. 9–13.

A large species of *Conocardium* is represented by a specimen crushed almost beyond recognition. It measured about 18 mm. across the valves, and its plaits were strong, squared, and close-set. It appears not to have had any flattened central region. What is seen of it suggests that it might be a small specimen of Römer's shell, which, however, often reaches much larger dimensions.

Passage beds of Lower Devonian to Calceola-schists.

ATHYRIS CONCENTRICA, von Buch, sp. (Pl. XVIII, Fig. 6.)

1895. *Athyris concentrica*, Kayser: Ann. Soc. Géol. Belg., vol. xxii, p. 207, pl. iii, figs. 7, 8 ?, 9 ?

A few rather small and obscure specimens are referable to this species. The fold, though pronounced, seems similar in character to Davidson's figures from Hope's Nose, and is not subangular as in *A. undata*, Defr. A mould of the closed valves shows the characteristic strong concentric ridges.

Coblenzien of Belgium, but not in the Rhenish Lower Devonian (Kayser).

SPIRIFERA CURVATA, Schlotheim, sp. (Pl. XVIII, Figs. 2, 3, 3*a*.)

1853. *Spirifer curvatus*, Schnur: Palæontogr., vol. iii, p. 208, pl. xxxvi, figs. 3*a*, *b*.

Several specimens of a very large *Spirifer* occur, but all in a fragmentary and distorted condition. They are apparently a good deal wider than long, and are entirely without ribs. The fold is elevated, rounded, and very much produced in front; and the sinus is deep from near the umbo, and forms a very long tongue-shaped projection in the front of the ventral valve. Some specimens (Fig. 3*a*) preserve the surface-ornament, and show it to consist of fine, regular, concentric, elevated lines, bearing minute punctations, which are the endings of still more minute, discontinuous, radiating lineations.

These shells seem to be like Schnur's figure quoted above and Davidson's from Hope's Nose, though probably they were wider. I am not inclined to follow Beushausen in regarding the very variable form of the Lummaton Beds as more than a variety of this species.

Upper Coblenzien and higher beds.

SPIRIFERA PRIMÆVA, Steininger.

1895. *Spirifer primævus*, Béclard: Bull. Soc. Belg. Géol., vol. ix, p. 137, pl. xi, figs. i–vii, 1–12.

Several rather small casts and moulds appear to belong to this species, exactly resembling *S. Beaujeani*, Béclard, which that author afterwards merged into Steininger's shell. They are a good deal wider than long, with rather rounded cardinal angles, a very deep sinus, and (in the smallest specimen) five strong rounded ribs on the wing. The surface is covered by very strong close-set concentric ridges, becoming coarser in front, and united by strong radiating lines. One specimen is 50 mm. wide.

Throughout Lower Devonian of Europe.

ATRYPA RETICULARIS, Linné, sp.

This shell seems rare, being represented by a single mould.

Upper Coblenzien and higher beds.

PENTAMERUS GALEATUS, Dalman, sp. (Pl. XVIII, Figs. 4, 5.)

1853. *Pentamerus galeatus*, Schnur: Palæontogr., vol. iii, p. 196, pl. xxix, fig. 2.

Cast large, globose. Umbo large, much recurved. Area wide, undefined laterally. Dorsal valve smaller than the ventral and with a deep, flattened, receding sinus, a corresponding fold being on the ventral valve. Shell covered with strong ribs, reaching nearly

to the umbo; from three to five being on the fold and five or six on each side.

Size: A specimen that has hardly been distorted is 40 mm. in length and width, and 20 mm. in depth. A flattened specimen is nearly 50 mm. long.

This species is the prevailing shell of the locality. Very large numbers of specimens have been found, but always in the condition of casts.

From Silurian to Middle Devonian (Kayser).

ORTHIS HYSTERITA, Gmelin.

1853. *Orthis Beaumonti*, Schnur: Palæontogr., vol. iii, p. 215, pl. xxxvii, fig. 9.
1889. ,, *vulvarius*, Barrois: Ann. Sci. Géol. Nord, vol. iii, p. 72.
1889. ,, *hysterita*, Kayser: Abh. k.p. Geol. Landes., N.S., pt. i, p. 53, pl. v, figs. 1, 7–9.

Some casts of the double valves, showing the internal arrangements, appear to agree exactly with the shell by Schnur referred to *O. Beaumonti*, De Vern., and by Gosselet and Barrois to *O. vulvarius*, Schlot.; the latter remarking that it is distinguished from *O. striatula*, Schlot., by its long and stronger muscular impressions. Other larger casts of single valves equally correspond to Kayser's figures of the same shell, for which, following Quenstedt, he adopts a still earlier name.

The shape of these fossils is a transverse oval, the dorsal valve is deeply convex, the ventral valve is concave laterally and has a broadly arched sinus. The valves meet in a deep sweeping curve in front. The muscular area reaches rather more than half-way forwards in the smaller examples, and less than half-way in the larger. Only marginal traces of the very fine ribs remain.

Size: about 30 mm. long by 45 mm. wide.

Throughout the Lower Devonian of Germany.

ORTHIS, sp. (Pl. XVIII, Figs. 10*a*, *b*.)

Cast longer than broad, tumid. Dorsal valve very convex, larger than the other. Ventral valve apparently nearly flat, with a wide shallow sinus in front and reflexed sides, and massive near the umbo with a wide oblique hinge-area. Hinge-line as long as the width of the shell. Cardinal angles gently rounded. Valves meeting in front in a sweeping curve. Muscular impressions extremely large and strong, reaching very nearly to the front margin of the shell in both valves. Surface covered with very numerous small rounded striæ, which seem to divaricate close to the margins. Shell-structure thick.

Size: about 20 mm. long, 15 mm. wide, and 11 mm. deep.

There is a cast of the closed valves and an exterior of the dorsal valve, which retains the surface though much decayed. These specimens, together, show a good deal of the character of the species, which seems to me very distinctive. Internally, it appears very like *O. Monnieri*, Roualt, from the Lower Devonian, but it differs from it in shape and in the size of the hinge-area. I have seen very similar specimens from the Lower Devonian of Cornwall.

ORTHOTETES UMBRACULUM, Schlotheim, sp. (Pl. XVIII, Figs. 7, 7*a*.)

1865. *Streptorhynchus umbraculum*, Davidson: Brit. Foss. Brach., vol. iii, p. 76, pl. xvi, fig. 6; pl. xviii, figs. 1–5.

A few moulds of this species occur, which are interesting from their having well preserved the minute surface-ornament, which has been described by Davidson, but is rarely, if ever, fully seen in the numerous specimens from Lummaton and other higher beds. A wax-cast shows this to consist of very numerous and regular "scale-like projections on the striæ," which are not only connected in the interspaces by the corresponding growth-lines, but by a still finer superficial series of elevated microscopic lineations, slightly irregular and arching, and at the rate of about five to each growth-line. This finer ornament is so minute that it can only be seen by a strong lens, but it is extremely beautiful.

Lower and Upper Coblenzien and higher beds.

STROPHOMENA RHOMBOIDALIS, Wilckens.

This species is represented by a fine cast of the closed valves and by an interior of the lower valve. The former appears to have been a very deep shell, and shows much detail; its characteristic ornament can be discerned on the covering mould.

Upper Coblenzien and higher beds.

STROPHEODONTA TÆNIOLATA, Sandberger, sp. (Pl. XVIII, Figs. 8, 8*a*, 8*b*, 9, 9*a*, 9*b*.)

? 1842. *Orthis Sedgwickii*, D'Arch. & De Vern.: Geol. Trans., ser. II, vol. vi, p. 371, pl. xxxvi, fig. 1.

1853. *Strophomena tæniolata*, Sandberger: Verst. Rhein. Nassau, p. 360, pl. xxxiv, fig. 11.

Shell apparently convex, somewhat deflexed in front, and about as long as wide. Hinge-area narrow, as long as the width of the shell, bearing numerous strong dentations. Ornament consisting of multitudinous, fine, straight, regular striæ, divided into groups of five or six by somewhat stronger ribs, half of which only reach half-way to the umbo.

Size: about 20 mm. long by 25 mm. wide.

This species is not very rare in these beds, but the specimens are very much squeezed and fragmentary, probably from its being a delicate shell. Its ornamentation was evidently very beautiful.

It appears exactly to agree with the shell figured by Sandberger, who quotes *O. Sedgwickii* as a synonym. If that be so, of course this latter name would have priority; but I am by no means sure of its identity with that shell, whether as described by De Verneuil or by Schnur, and am more inclined to believe it to be the species attributed by Schnur and by Barrois to *Leptæna interstrialis*, Phillips, which itself is certainly distinct from it.

Spiriferen-sandstein of Daleiden (Sandberger).

FENESTELLA TORWOODENSIS, n.sp.

Some specimens, apparently of a frondose habit, have been found. Their branches are slight (being much narrower than the fenestrules),

appear to divaricate about once to seven or eight fenestrules, and bear a very much elevated, blade-like keel within. The fenestrules are long flattened ovals, about 6 to 10 mm. in length and 13 to 10 mm. across. There are four or five cells to a fenestrule.

This probably belongs to the species figured by Phillips as *F. antiqua*, var. *a*, from Lynton; but it also comes extremely close to the Hope's Nose fossil, which I have referred to his *F. arthritica*, differing from it in probably branching more rapidly and in certainly having the cell-mouths and keel on the outside face.

Hallia quadripartita, Frech.

1886. *Hallia quadripartita*, Frech: Palæont. Abhandl., vol. iii, pt. 3, p. 83, pl. viii, figs. 20, 21.

Simple, cornute, oval in section; axis excentric. Cup deep. Major septa 28. Septal fossula deep, extending to centre and containing the principal septum, which does not reach the centre. Opposed and lateral septa reaching centre. Septa of each principal quadrant 5, pinnate against the septal fossula; and those of each opposed quadrant 7, pinnate against its lateral septum. Minor septa 28, long.

Size: about 23 mm. wide.

There is one specimen from this locality, but the above description has been completed from an example from near "Walls Hill," which is in better preservation and contains forty-six septa. It seems perfectly to correspond with Frech's German species.

Lower? *Stringocephalus* Beds of Gerolstein.

Amplexus, sp.

Conical. Cup very deep (about 25 mm. deep by 25 mm. wide), flattened at the base. Major septa 28, reaching half-way to the centre. Minor septa rudimentary. Tabulæ (as seen at the base of the cup) irregularly flat, extending to the sides, and marginally deflexed. Septal fossula very deep, marginal, not extending half-way to the centre, and containing a short septum, while the adjoining septa arch round its sides. No dissepiments.

The specimen, being only the distorted cast of the cup, is not easy to decipher, but belongs, I think, clearly to this genus. As far as can be seen, it approaches somewhat nearly to the Carboniferous *A. cornu-bovis*, Edwards & Haime.

Metriophyllum Elsii, n.sp.

Small, apparently elongate, sub-conical, about 10 mm. wide. Major septa 16, reaching to the centre, where they are slightly deflexed. Minor septa 16, long. Signs of a large pseudo-columella, which appears to be formed by the invagination of the centre of the arching tabulæ.

This form seems the commonest true coral of the zone, though rather rare. It is so similar in style and structure to *Metriophyllum gracile*, Schlüter, that it is doubtless congeneric; but it differs from it specifically in the central twisting of the septa, the probably looser structure of the columella, and other points.

EXPLANATION TO PLATE XVIII.

DEVONIAN FOSSILS FROM TORQUAY.

The specimens belong to the Torquay Natural History Society, and were obtained from the foundations of its Museum. They are drawn to natural size.

FIG. 1.—*Capulus priscus*, Goldfuss?
FIG. 2.—*Spirifera curvata*, Schlotheim, sp. Portion of ventral valve.
FIG. 3.—The same. Central part of the front of dorsal valve, showing the fold. Fig. 3*a*, portion of surface magnified.
FIG. 4.—*Pentamerus galeatus*, Dalman, sp.
FIG. 5.—The same.
FIG. 6.—*Athyris concentrica*, von Buch, sp. A small dorsal valve.
FIG. 7.—*Orthotetes umbraculum*, Schlotheim, sp. Mould showing the minute ornamentation. Fig. 7*a*, portion of the mould magnified.
FIG. 8.—*Stropheodonta tæniolata*, Sandberger, sp. Lower valve and hinge-line. Fig. 8*a*, portion of hinge-line magnified. Fig. 8*b*, portion of front of the valve magnified, showing the double series of striæ.
FIG. 9.—The same. Lower valve showing internal arrangements. Fig. 9*a*, portion of hinge-line magnified. Fig. 9*b*, portion of ovarian area, showing its pitted surface.
FIG. 10.—*Orthis*, sp. Fig. 10*a*, cast of dorsal aspect. Fig. 10*b*, cast of ventral aspect.
FIG. 11.—*Cladochonus* cf. *Schlüteri*, Holzapfel. Mould of the part of a specimen.
FIG. 12.—*Pleurodictyum*? *pachyporoides*, n.sp. Portion of a ramose cast. Fig. 12*a* portion of one of the corallites magnified, showing the arrangement of the rods.

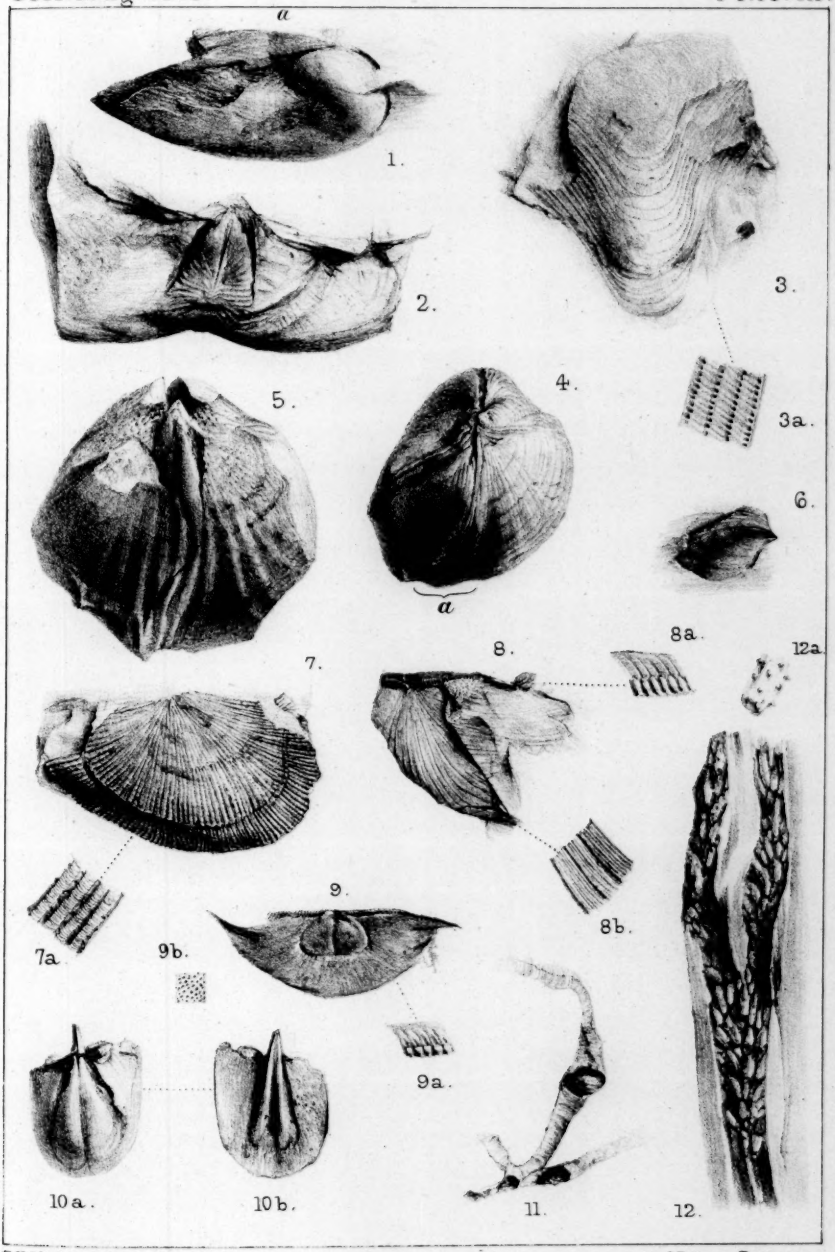
II.—THE FAYÛM DEPRESSION: A PRELIMINARY NOTICE OF THE GEOLOGY OF A DISTRICT IN EGYPT CONTAINING A NEW PALÆOGENE VERTEBRATE FAUNA.[1]

By HUGH J. L. BEADNELL, F.G.S., F.R.G.S., of the Geological Survey of Egypt.

THE Fayûm, one of the largest depressions of the Libyan Desert, is situated some 50 miles south-west of Cairo. It is cut out in rocks of Eocene and Oligocene age, while still younger deposits of Pliocene and Post-Pliocene date are found within the hollow. The depression owes its origin to the action of the ordinary subærial denuding agents, which I have shown in previous papers were capable of producing the oases-depressions of Baharia, Farafra, Dakhla, etc. Faulting, which has played so important a part in the formation of the Nile Valley, appears to have had little or nothing to do with the production of the Fayûm and other depressions of the Libyan Desert.

During my survey of the Fayûm in 1898 I found that certain strata of the Middle Eocene were veritable 'bone-beds,' being crowded at many points with vertebrate remains, such as the ribs of cetaceans, crocodile vertebræ, fish-bones, and coprolites. Up to that time the only vertebrate fossils which had been obtained from the district were remains of *Zeuglodon* and some fragments of a mandible thought to belong to *Chœropotamus*; these had been collected by Schweinfurth and noticed by him in 1886.

[1] Communicated in abstract to the British Association at Glasgow, 1901, by permission of Sir William Garstin, K.C.M.G., Under-Secretary of State, and Capt. H. G. Lyons, Director-General of the Survey Department, Cairo.



F.H. Michael del. et lith. Mintern Bros. imp.

Devonian Fossils; Torquay.

In the early part of 1901 I spent a short time in the Fayûm exploring the borders of the Birket el Qurun lake, on which occasion Dr. C. W. Andrews, of the British Museum, who happened to be in Egypt at the time, accompanied me. On our return journey to Cairo we visited some of the localities I had found to be bone-bearing in 1898, and on our last day's march were most fortunate in crossing the Eocene escarpments at a point where a number of well-preserved marine and terrestrial vertebrate remains lay exposed on the surface of the outcrop of the bone-beds. On reporting, Capt. H. G. Lyons, Director-General of the Survey Department, at once organized a special collecting expedition; Dr. Andrews again accompanied me, and together we succeeded in obtaining a unique collection of almost entirely new mammals and reptiles. A brief description of these is now being published by my companion in the Geological Magazine (see September and October issues), and the object of the present paper is to give a preliminary account of the geology of the district from which these interesting remains were obtained.

General Succession.

The oldest beds found in the depression are the clays, marls, and limestones, with *Nummulites gizehensis*, of Middle Eocene age. These are succeeded by a group of white marly limestones and gypseous clays, which largely underlie the cultivated land of the Fayûm. They are followed by a series consisting of clays, sandstones, and calcareous grits, some beds of which are characterized by the abundance of *Operculina*. The latter series is followed by the uppermost marine Eocene beds (Carolia beds), an alternating group of clays, sandstones, and limestones, characterized by an abundant vertebrate and invertebrate fauna, and equivalent to the Upper Mokattam beds of Cairo. Above the 'Carolia beds,' and well marked off from them, both lithologically and palæontologically, is found a great thickness of variegated sands and sandstones, clays, and marls, divided near the summit by one or more thick intercalated lava sheets. These variegated beds are largely of fluvio-marine origin and are of Upper Eocene – Lower Oligocene age. No Miocene deposits have been recognized within the area, but further north, as at Mogara, Lower Miocene beds occur, and it is probable that a continuous conformable series of lithologically similar deposits extends from the summit of the Fayûm escarpment (Lower Oligocene) to the Mogara Miocene beds.

The Pliocene is probably represented by the great masses of gravel, or raised beaches, which form such a marked feature in the geology of the district. Fossiliferous Pliocene deposits have also been recorded from the south part of the area by Schweinfurth. Of Post-Pliocene age we may mention the ancient high-level lacustrine clays, the cultivated alluvial loams, and the desert sand-dunes.

The following table shows the sequence of strata known in the Fayûm and the classification adopted by the writer:—

Recent and Pleistocene.	Alluvial soil, blown sand, and high-level lacustrine sands and clays.
Pliocene.	Shell-borings on exposed rocks. Fossiliferous deposits of Sidmant. Gravel terraces.
Lower Oligocene and Upper Eocene.	5. Fluvio-marine Series (Gebel el Qatrani beds).
Middle Eocene.	4. Qasr el Sara Series (Carolia beds). 3. Birket el Qurun Series (Operculina-Nummulite beds). 2. Ravine Beds (fish-scale marls). 1. Wadi Rayan Series (*Nummulites gizehensis* beds).

1. Wadi Rayan Series.

The wadis of Rayan and Mouailla, on the southern side of the Fayûm depression, are cut out in the clays and limestones of this group, equivalent to part of the Lower Mokattam of the Nile Valley. The uppermost bed of limestone, characterized by the profusion of the large foraminifer *Nummulites gizehensis*, forms a considerable part of the floor of the depression west of the Fayûm cultivation, stretching from Gebel Rayan northwards to the foot of Gar el Gehannem, 28 kilometres west of the western extremity of the Birket el Qurun.

2. Ravine Beds.

This series, estimated at 25 metres thick, consists of gypseous clays and white marly limestones, and is met with bordering the cultivated land on the east, west, and north sides. The same beds are frequently exposed in the deep ravines of El Butts and El Wadi which intersect the cultivation. The beds yield shell-impressions of *Leda*, *Tellina*, etc., with fish-teeth and numerous scales. No vertebrate remains have as yet been obtained from this or the underlying series. Beds of this group form the base of the island 'Geziret el Qorn' and the lower part of the northern shore of the Birket el Qurun.

3. Birket el Qurun Series.

The beds of this group, some 60 metres thick, form the main part of the escarpment immediately overlooking the north shore of the lake. The series appears to be the equivalent of the upper part of the white beds (limestones) of Gebel Mokattam, although lithologically there is considerable difference. Certain beds of the series are characterized by the abundance of two foraminifera, *Nummulites Fraasi* and *Operculina discoidea*. A well-marked molluscan fauna is also present, and cetacean and fish remains are not uncommon. The series is well seen in the desert separating the Fayûm and Nile Valley, along the northern boundary of the cultivation and of the lake, and westwards in the cliffs to the outlying hill-mass of Gar el Gehannem.

In the northern part of the Fayûm the series is divisible by a very constant well-marked bed of hard sandstone, which almost invariably weathers out into a number of huge globular masses. The lower beds are seen in the island of Geziret el Qorn, and from

them Schweinfurth first collected cetacean remains. The mollusca from these beds were described by Mayer-Eymar (Zittel, *Palæontographica*, N.F., X, 3 (XXX)) as having on the whole a Bartonian aspect, but his determination seems much open to doubt, as they underlie the Upper Mokattam (Qasr el Sara series), the Parisian age of which appears to be well established. The cetacean remains were described by Dames, who compared them with the American *Zeuglodon macrospondylus* and *Z. brachyspondylus*, but did not consider them to represent a new species. The same author, however, subsequently described similar but more complete remains (also collected by Schweinfurth, from beds belonging to my Qasr el Sara series) as a new species, *Z. Osiris*. The upper division of the Birket el Qurun series is lithologically rather similar, consisting of alternating clays and sandstones. The beds, however, are generally much richer in organic remains. In the uppermost beds very large cetacean vertebræ occur, and these probably represent a second species of *Zeuglodon*, as although Dames considered the difference in size of the bones of separate individuals to be sexual, the apparently much greater upward range of the smaller type suggests the existence of two species.

4. Qasr el Sara Series.

The exact junction between this and the last-described series is purely arbitrary, some of the commonest fossils passing from one to the other. The name of the series is taken from an ancient ruined temple near which the beds are well developed. The Qasr el Sara series (or Carolia beds) is perhaps the most important and best marked division of the Fayûm succession; it forms a bold escarpment of great length and height, consisting of a series of very fossiliferous clays and limestones, with sands and sandstones in the upper part of a total thickness of 175 metres. The 'Carolia beds' closely correspond to the Upper Mokattam division of the Eocene at Cairo, but are much more fully developed in the Fayûm, where they occupy a large part of the northern desert. In the cliffs about 8 kilometres north of the Birket el Qurun the beds form a steep double escarpment, running nearly parallel to the northern shore of the lake.

Vertebrate remains may be found in places in most of the beds of this division, but the most prolific horizon is the 'bone-beds' proper, a double band of clay separated by two layers of limestone, and occurring about midway in the series. In this bed groups of skeletons, or portions of skeletons, are occasionally met with, suggesting that they were carried out to sea by a strong river current and deposited at the tail-end of the latter. That the Qasr el Sara series was deposited in fairly shallow water at no great distance from land seems certain, no less from the common occurrence of terrestrial animal remains than from the general lithological character of the beds. The clays abound with impressions of plants, much lignitic matter occurs, current-bedding is well seen in many of the more sandy beds, while the thin interbedded bands of limestone

are more or less impure and do not indicate conditions of any great depth.

The commonest and perhaps the most important mammal from these beds is *Mœritherium Lyonsi*, Andr., which Dr. Andrews considers to be a generalized forerunner of the Mastodon type of Proboscidean; a second species may also be present. The mandible and upper teeth, together with some of the limb bones of a large heavily built ungulate, somewhat resembling *Dinotherium*, have also been described as *Barytherium grave*. Sirenian remains are not at all rare and may belong to *Eotherium ægyptiacum*, Owen, the type of which was a natural brain-cast from the Mokattam beds of Cairo. It is possible, however, that the Fayûm animal may yet prove to be distinct from *Eotherium*. Cetacean remains are remarkably common in these beds, and all appear to belong to *Zeuglodon Osiris*; the larger cetacean bones, mentioned as occurring in the underlying beds, have not here been detected. Reptiles are represented by two new genera of snakes, the larger of which, *Gigantophis Garstini*, Andr., was a python-like type, and probably attained a length of 30 feet. The remains of the smaller *Mœriophis Schweinfurthi*, Andr., in the shape of well-preserved vertebræ, are remarkably abundant. Two new species and one new genus of chelonians were obtained from this series and have been described as *Psephophorus eocænus*, *Thalassochelys libyca*, and *Stereogenys Cromeri*. Crocodilian remains abound, the most important new species being *Tomistoma africanum*, Andr. Fish-remains occur throughout the series, one of the commonest forms being a large, and probably new, species of Siluroid. Fragments of the Saw-fish, *Propristis Schweinfurthi*, are also frequently met with.

5. Fluvio-marine Series.

In the north of the Fayûm, the Qasr el Sara series is always conformably overlain by a unique series of variegated sands and sandstones, with alternating clayey and marly bands. The often repeated bands of limestone of the underlying division are now only represented by an occasional bed of calcareous grit or impure limestone. Near the top of the series occurs a horizontal sheet of basalt, in all probability contemporaneously interbedded. For the most part the series is barren of organic remains, but certain bands in the upper part yield numerous individuals of *Unio*, *Spatha*, *Mutela*, *Ampullaria*, *Turritella*, *Cerithium*, *Melania*, and *Potamides*. From such a facies, we may without doubt conclude that the conditions of deposition of these sediments were estuarine or fluvio-marine. Moreover, the enormous quantities of silicified wood, in the shape of hundreds of trees of great length and girth, associated with the remains of terrestrial animals (*Palæomastodon*, etc.), show that rivers of considerable size emerged from the land to the south, the coast-line of which was probably not very far distant.

The series attains a maximum thickness of about 250 metres. With regard to age, I have already stated[1] that the lower part of

[1] Beadnell: "Recent Geological Discoveries in the Nile Valley and Libyan Desert"; London, 1901.

the series may be regarded as Upper Eocene, while the higher beds above the interbedded basalt marks the base of the Lower Oligocene. It seems probable that this age-determination will hold good, although whether it will ever be possible to draw a precise junction between the Eocene and Oligocene is more than doubtful. The series is quite continuous in the field, and the passage from the one to the other formation appears to be perfectly gradual, both lithologically and palæontologically.

Occasional fragments of bone may be observed in many parts of the series, but, so far, the only remains of value obtained were unearthed from the lowest bed, and are thus certainly of Upper Eocene (Bartonian) age. The most important terrestrial animal is *Palæomastodon Beadnelli*, Andr., a small generalized form of proboscidean, and probably a direct descendant of *Mœrithium Lyonsi* of the Qasr el Sara series below. Part of the mandible of another and different ungulate was also obtained, but has not yet been determined. In addition, remains of crocodiles and turtles are not uncommon in the basal beds of the 'Fluvio-marine Series.' The post-basalt portion of the series forms the highest part of the escarpment on the north of the Fayûm depression. These beds cover the desert to the north, stretching to beyond the latitude of Cairo. To the north-west, however, they appear to pass gradually up into younger deposits, as at Mogara Lower Miocene rocks occur.

Space does not permit of any details being given here of the younger Tertiary and Post-Tertiary Fayûm deposits.

General Remarks.

The Eocene rocks of the Fayûm are of special importance, owing to the presence in them of a new and highly interesting succession of vertebrate remains, enabling us to gain some insight into the nature of the fauna at that time inhabiting the great African land-mass to the south. In the region to the west of the Nile Valley, comparatively shallow water existed from probably the beginning of the Middle Eocene, and numerous rivers entered the sea in this neighbourhood, bringing quantities of forest trees and floating carcases of animals from the south. To the east deeper water must have existed, as limestones continued to be accumulated until the latter part of the Middle Eocene period, and even then the amount of land sediment deposited was much less than in the Fayûm. Later, in Upper Eocene times, while the Fayûm appears to have been the site of an enormous delta, no deposits of the same age at all appear to have been laid down to the east of the present Nile Valley, as there the top beds of the Middle Eocene (Upper Mokattam) are unconformably overlain by the Oligocene deposits of Gebel Ahwar, etc.

It is to be hoped that further exploration in the Fayûm and surrounding desert regions may in time lead to palæontological discoveries of the highest importance. Some of the primitive ancestors of the proboscidea have already been discovered, and it is not improbable that in the still lower Rayan series earlier and still

more generalized forms may eventually be unearthed. Up to the present time it has been maintained, by some authors at least, that at the close of the Pliocene or commencement of the Pleistocene period a great immigration of the Europasian ungulates took place into Africa; whereas the recent discoveries in Egypt show this theory to be untenable, as it was in the ancient African Continent itself that the elephants, and possibly some other groups, were evolved.

III.—Notes on Royle's Types of Fossil Plants from India.

By E. A. Newell Arber, B.A.,

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In his Illustrations of the Botany of the Himalayan Mountains, published in 1839, Royle[1] figures several important fossil plants from the Burdwan Coalfield of India. These are of especial interest, not only as being the first mention of several of the best known fossil types from the Lower Gondwanas of India, but also as among the earliest descriptions of members of the *Glossopteris* flora.

Royle's types are now in the Geological Department of the British Museum (Natural History), Cromwell Road. The object of this notice is to call attention to the whereabouts of these types, and to some of the more important morphological features which they present. A full account of the literature, in which reference is made to these fossils, will be found in Feistmantel's[2] Flora of the Lower Gondwanas of India, and need not be recapitulated here. The horizon in the Lower Gondwanas, from which these plants were obtained, is the Ráníganj group of the Damuda Series.

Sphenophyllum speciosum (Royle). [V. 4,190.][3]

1837. *Trizygia speciosa*, Royle: ibid., p. xxix*, pl. ii, fig. 8.
1881. ,, ,, Feistmantel: ibid., p. 69, pls. xi *a*, xii *a*, figs. 1, 2.

The type figured by Royle under the name *Trizygia speciosa* is a very interesting one. It is a fine specimen, 6 inches long and $2\frac{1}{2}$ inches across, and showing nine whorls of leaves. The stem is slender, $\frac{1}{32} - \frac{1}{16}$ inch across. The internodes have two fairly prominent longitudinal ridges, but the preservation is not sufficiently good to show that these ridges are continuous at the node. Each node bears a whorl of three pairs of leaves, unequal in size, and consisting of four elongate-ovate, entire, and spreading leaves, $1\frac{1}{8}$ inch long by $\frac{3}{8}$ inch broad, and a smaller pair, $\frac{5}{8}$ inch by $\frac{3}{8}$ inch, ovate and reflexed. The successive whorls are superposed.

In the arrangement and unequal size of the leaves, *S. speciosum* differs from the majority of European Sphenophyllums, to which,

[1] Royle: "Illustrations of the Botany and other branches of Natural History of the Himalayan Mountains, and of the Flora of Cashmere"; London, 1839.

[2] Feistmantel, "The Fossil Flora of the Gondwana System": Mem. Geol. Surv. India, 1881, ser. xii, vol. iii. (The Flora of the Damuda and Panchet Divisions, 1880.)

[3] Registered number of specimen in the Geological Department, British Museum.

however, it is in other respects nearly related. Feistmantel,[1] for these, and for other reasons which M. Zeiller and Mr. Seward[2] have since shown to be untrustworthy, supported Royle in assigning the Indian plant to a separate genus, *Trizygia*. But M. Zeiller[3] has further shown that the unequal size and arrangement of the leaves in such specimens is not a constant feature of either generic or specific value, and that it sometimes occurs among such European species as *S. oblongifolium* and *S. filiculme*, from the Upper Coal-measures and Permian. M. Zeiller therefore rejects the genus *Trizygia*, a view which Mr. Seward[4] has supported in his textbook on Fossil Plants.

The occurrence of such a typical Coal-measure genus as *Sphenophyllum*, in association with members of the *Glossopteris* flora in the Lower Gondwanas of India, is a point of special interest, as showing that in India, as in similar beds in South Africa, and in South America, there occur plants which are typical of the flora of Europe and North America in Permo-Carboniferous times.

Vertebraria indica, Royle. [V. 4,189.]

1839. *Vertebraria indica*, Royle: ibid., p. xxix*, pl. ii, figs. 1–3, 5–7.
1881. ,, ,, Feistmantel: ibid., pl. xii *a*, figs. 10, 11; pls. xiii *a*, xiv *a*, fig. 11; pl. xiv *a* bis, fig. 3.

Royle says "the shales of Ranigunj and Chinnakooree contain abundant vegetable remains of the Ranigunj Reed, *Vertebraria indica*, and *Vertebraria radiata*." It is now known that both these species represent different views of the rhizome of *Glossopteris*;[5] *V. radiata*, the transverse section, and *V. indica*, the surface view.

Three specimens of each of these are figured by Royle. I have only been able to identify one large specimen[6] figured as *V. indica*. This is $5\frac{3}{4}$ inches long, and $\frac{3}{4}$ inch across. It is composed of two regular longitudinal rows of small square ($\frac{3}{8} \times \frac{3}{8}$ inch), or slightly oblong ($\frac{1}{4} \times \frac{3}{8}$ inch) areas.

As seen in transverse section, judging by Royle's figures, the structure of *Vertebraria indica* is very similar to that of *Vertebraria australis* (McCoy). In surface view, however, there is less resemblance. The areas, which represent the broad outer edges of the wedge-like segments composing the fossil, are in the Indian specimens small, and fairly regular, in size. From other Indian specimens figured by Feistmantel, this would seem to be a constant characteristic. In Australian specimens[7] they appear to be often very irregular, and to vary greatly in size. Oldham[8] has pointed out that the *Vertebraria* described by Zeiller from South Africa also differs from

[1] Feistmantel: Rec. Geol. Surv. India, 1879, xii, p. 163.
[2] Seward: Mem. and Proc. Lit. Phil. Soc. Manchester, 1889, vol. iii, p. 1.
[3] Zeiller: Bull. Soc. géol. France, 1890–91, ser. III, vol. xix.
[4] Seward: "Fossil Plants," vol. i; Cambridge, 1898.
[5] Zeiller: Bull. Soc. géol. France, 1896, ser. III, vol. xxiv, p. 349.
[6] Pl. ii, fig. 1.
[7] Feistmantel: Mem. Geol. Surv. N.S. Wales, Palæont., No. 3, 1890, pl. xiv, fig. 6; pl. xv, figs. 1–3.
[8] Oldham: Rec. Geol. Surv. India, 1897, vol. xxx, pt. 1.

Indian specimens. Although it is highly probable that all these species are the remains of the rhizome of one and the same plant, *Glossopteris Browniana*, Brongt., yet it would not seem possible to unite them, on account of the variation in structure [1] which they present.

Macrotæniopteris danæoides (Royle). [V. 4,191.]

1839. *Glossopteris danæoides*, Royle: ibid., p. xxix*, pl. ii, fig. 9.
1881. *Macrotæniopteris danæoides*, Feistmantel: ibid., p. 88, pls. xx *a*, xxi *a*, figs. 1, 2.

This specimen, which is beautifully preserved, measures $5\frac{1}{2}$ inches, and nearly $2\frac{1}{2}$ inches across. The midrib ($\frac{3}{32}$ inch across) gives off at right angles parallel veins, which are distant ($\frac{1}{32}$ inch), and simple, or occasionally dichotomizing. There is no regular alternation between the simple and branched veins. The leaf is oval-lanceolate, and the margin entire or undulate.

The generic value of *Macrotæniopteris* is a doubtful one. It would perhaps have been better, in the present state of our knowledge, to have included such forms under the broad definition which Mr. Seward [2] has adopted in dealing with similar remains. The chief distinctions between *Macrotæniopteris* and *Tæniopteris* are apparently the simple frond of large size—a point of doubtful value—and the distant secondary nerves, in the former case. It is therefore open to question whether a generic distinction based only on such characters will eventually be found to hold good.

Cladophlebis Roylei, Arber. [V. 4,192.]

1839. *Pecopteris Lindleyana*, Royle: ibid., p. xxix*, pl. ii, fig. 4.
1881. *Alethopteris Lindleyana*, Feistmantel: ibid., p. 80, pl. xviii *a*, figs. 2, 2*a*; pl. xix *a*, figs. 3, 4.

Royle's specimen is a large bipinnate frond, the main axis of which is nearly 7 inches long, and some of the pinnæ are of a similar length. The pinnules, which are badly preserved, are somewhat oblong in shape, and attached by a broad base. The apex is rounded. They average $\frac{1}{2}$ inch long, by $\frac{5}{16}$ inch broad. There is a strong median nerve, from which dichotomizing secondary nerves are given off. Feistmantel's figures show the nervation accurately, but those of Royle, and especially of McClelland,[3] are somewhat misleading.

The general habit and the nervation recall certain fronds of a British Jurassic fern, *Todites Williamsoni* (Brongt.); so much so that Feistmantel [4] originally placed the Indian species in a group with *Alethopteris Whitbyensis*, Heer, a plant very possibly identical with *T. Williamsoni* (Brongt.).[5] The fructification of Royle's plant is known, and is of the Polypodiaceous type, and thus differs from that of Heer's plant, as Feistmantel [6] later admitted. It would seem

[1] Etheridge: Proc. Linn. Soc. N.S. Wales, 1894, ser. II, vol. ix.
[2] Seward: Brit. Mus. Cat., "The Wealden Flora," 1894, pt. i, p. 124.
[3] McClelland: Rep. Geol. Surv. India, 1849–50, pl. xiii, figs. 10*a*, 10*b*, 10*c*, 11.
[4] Feistmantel: Journ. As. Soc. Bengal, 1876, vol. xlv, p. 360.
[5] Seward: Brit. Mus. Cat., "The Jurassic Flora": I. The Yorkshire Coast, p. 88; London, 1900.
[6] Feistmantel: ibid., p. 80.

best to refer Royle's type to the genus *Cladophlebis*, a group of fossil ferns whose fructification resembles that of recent Polypodiaceæ, and of which the best known representative is *Cladophlebis denticulata* (Brongt.), from the English Oolite. I have called Royle's type *Cladophlebis Roylei*, as the term *Pecopteris Lindleyana* was in any case inadmissible, for it had been earlier applied by Presl to a fern now known as *Coniopteris arguta* (L. & H.).[1] The nervation in *Cladophlebis* and *Todites* is of the same general type, but the evidence of the fructification would seem to be strongly in favour of referring Royle's plant to the former genus.

PUSTULARIA CALDERIANA, Royle.

No scientific description is given by Royle of any of his types. All the plants he mentions are, however, figured, with the exception of one which he merely refers to as having been named by him *Pustularia Calderiana*.[2] The rock-specimen with *Cladophlebis Roylei* contains several other smaller fragments, and also bears a label with "*Pustularia Calderiana*" in probably Royle's handwriting. These specimens are imperfect, and perhaps for this reason were not figured. They apparently consist of slender branched specimens of *Vertebraria indica*, Royle, similar to those figured by Feistmantel.[3] As, however, Royle's plant was neither figured nor described, the name *Pustularia Calderiana* has no significance.

IV.—GEOLOGICAL NOTES ON THE NEIGHBOURHOOD OF LADYSMITH, NATAL. No. 2: ON SOME TRAVELLED BLOCKS IN THE ECCA SHALES.[4]

By Dr. H. EXTON, F.G.S.

(Communicated by Professor T. Rupert Jones, F.R.S., F.G.S.)

ON both sides of the Klip River running through this district a shale predominates, varying in colour from greyish-brown to purple, having a conchoidal fracture, and the features of Ecca Shale, as described by Dr. Molengraaf (Trans. Geol. Soc. South Africa, vol. iv, pt. 5, pp. 107–112).

The watercourses and dongas are too shallow to show the base of the Ecca series, and I have searched for the presence of Dwyka Conglomerate here without avail.[5] In a narrow gorge running into the Klip River near to this station is a level piece of ground covered with blocks, which, from the absence of a parent rock and from the

[1] Seward: ibid., p. 116.
[2] Royle: ibid., p. xxix*.
[3] Feistmantel: ibid., vol. iii, pl. xiii *a*, figs. 1, 2.
[4] For No. 1 see p. 509.
[5] Since Dr. Molengraaf's memoir on "The Origin of the Dwyka Conglomerate," describing the Ecca Beds as resultants of glacial action, much attention has been given to the subject. See the Trans. Geol. Soc. South Africa, 1898, vol. iv, pp. 103–115; and Nat. Science, 1899, pp. 199–202. In E. J. Dunn's Geological Map of South Africa (1887) the Ecca Beds range only up as far as the Tugela River in Northern Natal. The Ecca Beds described by Dr. Molengraaf are in the Vryheid district, just south of Utrecht and west of Zululand.

peculiarity of their disposition, appear to have been travelled blocks (Locality No. 1). Each one is more or less encased with a fine-grained sandstone, like the kernel of an almond in its shell, which to a certain extent takes the shape of the central mass.

These blocks, lying on the Ecca Shale, are well shown in the photographs Nos. 1 and 2, for which I am indebted to Captain Dalgleish, of the Newcastle Field Artillery.

"No. 2" shows an artificial pile of detached blocks, each partially exhibiting the crust or casing of sandstone. These stones have evidently been exposed, and possibly rolled from higher ground, and thus more or less fractured.

"No. 1" (see Fig. 1) shows a block still lying *in situ*, partially embedded in the Ecca Shale, size 27 × 19 × 12 inches. The immediate foreground shows the cutting of a military road, and by this the portion facing the spectator has been exposed, whilst the base of the block and the further portion remain embedded in the shale, as when planted there by natural agencies.

Fig. 1.—One of the encrusted blocks in the Ecca Shale near the Station Hospital, Ladysmith, Natal.

There is so much that to me is enigmatic in these stones that, with the stimulus your kindly interest in them has excited, I have extended my researches, with the result, as mentioned in mine of May 16th, that I found a similar specimen at Nicholson's Nek, four miles due north-east from this station (Locality No. 2), and on a second visit discovered others having the same characters. Since then I spent a satisfactory day at Bester's Farm (Locality No. 3), behind Waggon Hill, about five miles in a south-west direction from the Station Hospital (that is, *Stationary*, in contradistinction

from *Field Hospital*). This Bester's Farm (occupied by a man of that name) must not be confounded with "Besters," a railway station on the Harrismith line, about 16 miles from Ladysmith.

Following the watercourse (at this season merely a dry donga) towards the hills a mile and a half away from Bester's house I found many of these Olifant Klip[1] blocks *in sitú*, embedded in the blue shale. Some were embedded in the bed of the watercourse, but others were revealed by projecting from the almost perpendicular sides of the donga, having ten feet of shale between them and the surface of the ground. These are absolutely untouched by the hand of man. A casing of similar sandstone is here also evident; but, from moisture during the rainy season, more or less decomposition has ensued.

A blow with the hammer sufficient to break the crust generally detaches the same from its contained central mass; in order, therefore, that you may have the fullest opportunity of investigation I am having a small block sawn through by a local mason here, so as to give a section of the central portion still retaining its part of the crust above and below. This is from the site of my first find, on the declivity near the Klip River at this Station Hospital.

The thickness of the portion sliced off is 3 to 5 inches, and the diameters of its flat face are $16\frac{1}{2}$ by 12 inches.

In the same package I have enclosed specimens from the centre of blocks found by me at Bester's Farm. These, as far as I can see, possess the same characters as the specimens sent you by post at first.

The enquiry as to the source of these blocks becomes more interesting, and their geological relations more important, since I am now enabled to prove their presence on or in the Ecca Shale at four different points widely apart.

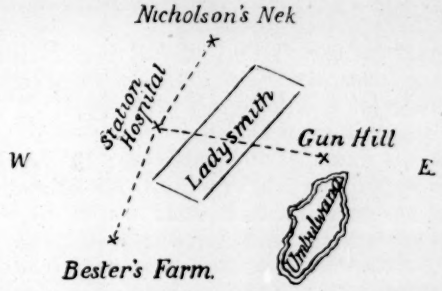


FIG. 2.—Showing the relative position of the four localities in which the travelled concentric blocks have been found in the Ecca Shales near Ladysmith.

The fourth point is in the Nek between Gun Hill and the mountain Umbulwana (Locality No. 4). Gun Hill is four miles east of Ladysmith and $5\frac{1}{2}$ from the Hospital Camp. At this Nek there are eight or ten blocks lying partially exposed, *in sitú*, on

[1] The kernel of these blocks resembles in microscopic structure the so-called 'Elephant Rock,' or 'Olifant Klip' of the Transvaal.

the Ecca Beds, with central mass and concentric coatings similar to the others already mentioned.

The occurrence of these peculiar blocks in large numbers, at places so far apart, points to some extensive physical operations under which their formation and deposition have taken place.

Mr. Fred. Chapman suggests that these blocks, with a more or less concentric structure, have been due to sigmoidal folds in crushed Palæozoic rocks. Their distribution was probably due to ice-action during the formation of the Ecca Shales.

The encrusted blocks and their association with the Ecca Shale are precisely the same in the four several localities in which I have now found them.

There can be no question about their being travelled blocks. I have been over the whole country within a radius of 15 miles round here, and have failed to find anything approaching the kind of stone of which the central portion consists. Therefore I am certain that I have not met with the rock from which these blocks were derived, nor, as far as I am aware, is there any previous mention of the occurrence in Natal of what I must perforce call 'dolomite,' such as the central mass of these encrusted blocks, which is a blue magnesian limestone, effervescing on application of a mineral acid.

[If the Ecca Beds are really extra-morainic deposits in connection with the Dwyka Conglomerate, it may be to the latter we have to look for the immediate source of the blocks, and to far-away southern regions for the earlier rocks from which they originally came.—T. R. J.]

V.—Notes on the Olifant Klip from Natal, the Transvaal, and Lydenburg.

By Frederick Chapman, A.L.S., F.R.M.S.

(Appendix to Dr. Exton's paper on the Travelled Blocks in the Ecca Shales near Ladysmith.)

I.—Specimen from one of the blocks lying on the Ecca Shale on the declivity near the Klip River at the Station Hospital, Ladysmith. This is a bluish-grey rock of close texture, with a flaky and sometimes conchoidal fracture. The broken surface does not reveal the rock's internal structure; but on the weathered surface, which appears as a brown crust, the siliceous strings and bands passing through the rock stand out in high relief. The surface effervesces freely when touched with acid.

Under the microscope this rock appears to be a mylonized siliceous limestone. It was perhaps originally a calcareous sandstone; possibly having organic remains (as shell-fragments), more or less massive.

The arenaceous part of the rock now appears as brecciated fragments of sandstone, alternating with contorted and fibrous calcareous material. The whole structure shows an extraordinary amount of crushing, and exhibits various stages in the formation of a cleaved rock. The harder arenaceous portion occurs as strings of rifted quartzose fragments, once continuous, but now broken

up and rippled, whilst between the folds, which are often sharp and V-shaped, the calcareous and other minerals lie in fibrous bands or intermingled with quartz-grains.

On the margins of the sandstone fragments some dolomite rhombs may be detected.

This 'Olifant Rock' is not a true dolomite, but a crushed limestone with much siliceous interstitial matter, and the crushing has given rise to a pretty 'rippling' of the granular portion, such as one often sees in the Skiddaw Slates and other rocks of a similar nature.

II.—The large block, from near the Hospital, is broken on one side, and has been sawn across carefully on the other to show its structure; and a large portion of the original surface exposed by weathering is seen on the rest of the specimen. It is evidently a portion of a sub-lenticular mass, consisting of an inner calcareo-siliceous material and an outer finer-grained siliceous and limonitic crust.

The whole block is strongly suggestive of its having been a lenticular mass, produced by intense folding, which has resulted in two contiguous, but differently constituted, layers being cut off in their continuity from the rest of the mass, as may be seen in certain of the folded Palæozoic rocks of the West of England, where a series of sigmoidal folds ultimately give rise to a band of separate lenticles. (See for instance Dr. H. Hicks' paper on "Folds and Faults in the North Devon Rocks," GEOL. MAG., 1893, pp. 3–9, especially the woodcut at p. 5.)

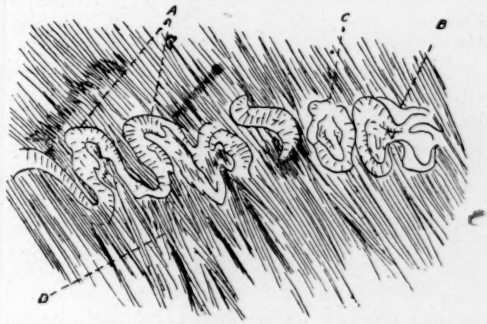


FIG. 3.—Sigmoidal folding in Devonian Rocks, east side of Hele Bay, Ilfracombe. To illustrate the origin of the concentric Olifant Klip blocks.

A. Ordinary sigmoidal fold in limestone.
B. Dumb-bell shaped fold due to pressure and thrust.
C. Isolated fold with crust and core.
D. Crushed and contorted slaty beds.

From a photograph by F. Chapman, 1899.

In explanation of the formation of the travelled and broken blocks found in the Ecca Shale near Ladysmith, as lenticles, in contorted Palæozoic strata, which have subsequently been broken out and then shifted by water or ice-action, the above section is given.

The microscopic structure of the inner portion of this Ladysmith specimen is seen to be both minutely and coarsely crumpled; whilst at short intervals the rock is traversed in various directions by small and interrupted faults. The weathering has brought out this structure of the internal portion very distinctly; and therefore the harder parts, with more silica in their composition, stand in high relief.

The forces which have produced the structures of 'rippling,' shearing, thrusting, and faulting in the central part of the mass have resulted in the formation of coarser vertical faults in the stronger and more homogeneous siliceous layer which now, probably through the folding process, forms the outer crust.

III.—A specimen from one of the blocks found in the Ecca Shale at Bester's Farm behind Waggon Hill, four miles from Ladysmith. This is a dark-grey rock, weathering on the dull side to a light-brown crust, along which harder bands of quartz stand out in strong relief. These hard bands are thin and almost papery in structure; and they are not continuous now, but nipped and disconnected by the oblique lines of the dynamical compression to which they have been subjected. The remnants of the siliceous bands are thus converted into a string of small lenticles.

The microscopic characters are like those of another specimen (from Ladysmith) above mentioned; that is, a contorted and mylonized siliceous limestone with much limonite.

IV. *Note on a specimen of the Olifant Klip of the Lydenburg District, from the Collection of Nicol Brown, Esq., F.G.S.*—This specimen shows strong indications of bedding lines, some of which, in consequence of their being siliceous, stand out in rugged relief. The rock also shows lines of faulting in a V-shaped manner (trough-faults). The surface of the limestone is coarsely hollowed or pitted (like elephant hide), and is of a dull bluish colour. Cold acid has no effect on the rock.

In section this rock is seen to be a dolomitic limestone. The main mass is composed of tesseræ of dolomite crystals with a few idiomorphic ones; that is, with their faces developed, especially in the clear parts of the section.

Darker patches in the rock, more finely crystalline to granular in structure, seem to point to former organic inclusions.

V. *Note on Olifant Klip from the Sterkfontein Caves near Johannesburg, in the Transvaal, in Mr. Nicol Brown's Collection.*—(1) A greenish or slate-coloured argillaceous limestone rock. Decomposing externally into a brown ochreous crust. Under the microscope this specimen shows itself to be much crushed, rapidly on the way to become a micaceous calc-schist. Minute quartz-grains interspersed through the section. Much limonitic material present. The apparent lamination seen on the fractured surface is probably due to cleavage.

(2) A sub-translucent, pale grey rock with oolitic structure. Composition, a dolomite. Under the microscope the larger proportion of this rock is seen to consist of minute rhombohedra of

dolomite, whilst some of the oolitic grains have patches of polysynthetic quartz, as a mosaic, near their centres. The concentric layers of the oolite granules seem to be marked out by a thin coating of graphite.

VI. *On the Olifant Klip from Lydenburg and Ladysmith; by* F. Rutley, F.G.S.—I do not see any ground to doubt that the rock from the Lydenburg district (see above) is other than what the label on the section states, namely, a dolomitic limestone. The prevalent rhombohedral forms, and the absorption of light when the polarizer alone is turned, suffice, I think, to show that the opinion is a correct one. The section of the rock (Olifant Klip) from Ladysmith is labelled "Crushed calcareous and siliceous rock." Probably if you have immersed a chip of the rock in H Cl you found a certain, but I suppose not very large, residue of insoluble matter. The section looks like limestone and sandstone crushed together, or very fine grit. The sand-grains are very small, and cemented by what I take to be limonite.

The sand-grains do not give satisfactory interference figures, but in one or two cases they appeared to be positive.

I find that I can make out nothing satisfactory from the small grains in the darker patches in the Olifant Klip. They do not give any trustworthy figures in convergent light. I suppose they are fragments of a fine grit.

VI.—On the Physical History of the Norwegian Fjords.[1]

By Prof. Edward Hull, M.A., LL.D., F.R.S., F.G.S.

THAT the Norwegian fjords were originally river valleys is a statement which scarcely admits of controversy. In their form, outline, and topographical position they are simply prolongations of the valleys which descend into the sea partly submerged; and if the land were still further submerged, as it once was to the extent of 200 metres according to Andr. M. Hansen, the fjords would be prolonged beyond their present inland limits without much variation of form.

The process of valley erosion by rain and river action is nowhere in Europe more admirably exemplified than in Western Norway, and the process may be supposed to have been in operation in the early formation of the fjord channels themselves before the epoch of submergence. But when we come to examine the form of the channels, as shown by the soundings marked on the Admiralty charts, we find ourselves confronted by the remarkable fact that the beds of the channels descend to very great depths, far exceeding those of the outlets where the fjords open out upon the floor of the North Sea. Now as river valleys must necessarily increase in depth (in reference to the surface of the sea) from their sources to their outlets, we are here brought face to face with a physical problem which apparently is inconsistent with our view of the original character of these channels as stated above. To the solution of this problem we must now shortly apply ourselves.

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

2. *General form of the fjord-beds.* — The numerous soundings laid down on the Admiralty charts of 1865 and 1886 enable us to determine with accuracy the form of the submerged portions of the fjords. Using these soundings, and by their aid laying down the isobathic contours, we arrive at results sufficiently remarkable. In the case of the Hardanger, the Feris, the Sogne, the Nord, the Vartdals, and the Stor Fjords with their branches, we find that shortly after passing the entrance from the outer sea, and the chain of islands which fringes the coast of the mainland, they rapidly descend to great depths, which are continuous for long distances inland, and then gradually become shallower toward the upper limits, where they pass into river valleys characterized by terminal moraines of ancient glaciers, or old sea terraces. In carrying out the mapping of the contours the author has adopted the following soundings:—

(1)	Those of the		100-fathom	contour		(600 feet).
(2)	„	„	200	„	„	(1,200 feet).
(3)	„	„	400	„	„	(2,400 feet).
(4)	„	„	600	„	„	(3,600 feet).

The floor of the Sogne Fjord descends to even greater depths than the last of these, viz. 661 fathoms (3,966 feet), which is reached in the case of this fjord at a distance of about 25 miles from the entrance. At the entrance itself the depth seldom exceeds 100 fathoms (600 feet), and is generally less; but once the deep water is reached there is little change of level for long distances. As regards the cross-section of the principal fjords, a glance at the charts shows that they retain the form of narrow channels with little variation in breadth, receiving tributaries on either hand and bounded by steep or precipitous walls of rock; as in the case of the valleys of which they are only prolongations under the surface of the sea.

3. When endeavouring to account for the peculiar form of the fjords and the depth of their floors over the central portions we must not forget that these old river valleys were the channels of great glaciers during the post-Pliocene or Glacial period, and that glacial erosion has contributed to the deepening process. Some Norwegian geologists, such as Hansen,[1] attribute the great disparity of the depth of the fjords at the inner and outer stages of their course to this deepening of the original channels by glacier erosion on the one hand, and to the piling up of enormous masses of moraine matter at the entrance on the other. To the latter cause the author fully assents; but he is doubtful whether glacier erosion has had the effect of adding many hundreds of feet to the depth of the original floor of the valleys. But leaving this question, we have to consider a second problem: namely, by what means did the original rivers empty themselves into the ocean before the Glacial period, when there was neither deepening of the floor by glacial erosion nor shallowing by moraine matter? Previous to the Glacial epoch the rivers must, in the

[1] "Norway," edited by Dr. Sten Konow and Karl Fischer, May, 1900. Translated by J. C. Christie and Miss Muir, and others.

author's view, have entered the Arctic Ocean through channels which cannot now be clearly traced by soundings over the shallow floor of the North Sea. At the same time it is certain that it was by such channels that they reached their ultimate destination in the Arctic Ocean, because rivers as they flow seawards must necessarily descend to lower levels. This being so, it follows that the channels do actually exist, though they may not be traceable by the soundings over the flow of the comparatively shallow North Sea; and we have now to consider why it is that they are untraceable.

The cause appears to be closely connected with the subsequent submergence in later or post-Glacial times, as indicated by the raised beaches and terraces.[1] During this epoch the glaciers had only partially disappeared or receded from the lower valleys. Great quantities of mud, sand, gravel, and boulders would thus be carried down by the streams and distributed by floating ice over the sea-bed. By such material the whole floor of the North Sea has been overspread to unknown depths, and owing to the agency of tides and currents may have been swept into the deep channels of the pre-existing rivers. The author is convinced that, were it possible to strip the floor of the North Sea of its sedimentary covering, these channels would be found traversing the floor of the continental platform, and ultimately opening out by cañon-like channels on the floor of the Arctic Ocean.

The phenomena here observed, or inferred, have their representatives along the coasts of the British Isles and Western Europe. In both cases there is the shallow continental platform, terminating in a deep and rapid descent to the floor of the abyssal ocean, and traversed by channels of ancient rivers traceable by the soundings in the case of Western Europe, or inferential in the case of Western Scandinavia. In a few cases these channels are for short distances clearly indicated on the charts; as, for example, in the case of the Bredsund Dybet, which is a prolongation of the Stor Fjord out to sea, between the islands of Godo and Harejdo in lat. 62° 30′, with a general depth of 100 fathoms below the adjoining floor of the sea; and there are a few other similar cases.

Outline of the physical history of the fjords.—As connected with the past history of the Norwegian fjords the following appear to be the most important stages:—

1st (Earliest) Period.—Continental conditions; Archæan rocks; river erosion begins.

2nd Period.—Partial submergence in early Silurian times.

3rd Period.—Elevation of land during Mesozoic and Tertiary periods; further deepening of river channels.

4th Period.—*Quaternary.* Early Glacial; great elevation of land and ultimate extension of snowfields and glaciers. Ice filling the valleys and moving out to sea.

[1] According to Professor Reusch the terraces with marine shells reach an elevation of about 200 metres (656 feet) in the Trondhjem district; but the author during a recent visit was unable to observe any higher than 250 feet south of this position.

5th Period.—*Quaternary.* Post-Glacial; subsidence and partial submergence of land; retreat of the glaciers. Icebergs and rafts of ice covering the adjoining sea. Amelioration of climate.

6th Period. — *Recent.* Re-elevation to approximately present position with regard to the outer ocean. Formation of raised beaches (strand linien) during the progress of emergence.

The paper concluded with a comparison between the above physical features as they occur in Norway with those of Scotland.

VII.—On the Circulation of Salt in its Relations to Geology.

By William Ackroyd, F.I.C., F.C.S., Public Analyst for Halifax.

A wrong impression is given by the question: "Why will Mr. Ackroyd not have the 19 rivers?" (Geol. Mag., November, 1901, p. 505). The data collected by Sir John Murray are admirable additions to our natural knowledge, and they are used in my last article (Geol. Mag., October, 1901, p. 448), but I contend that they are not available for use in the expression—

$$\frac{\text{Sodium in the sea.}}{\text{Sodium annually delivered into the sea by rivers.}} = \text{the age of the Earth;}$$

and I cannot accept either the minor or major limits of time arrived at in this way. Perhaps a few more lines are necessary to further amplify my reasons.

The 19 rivers contain the following compounds, among others, in tons per cubic mile of water: calcium and magnesium carbonates, 439,580; sodium sulphate, 31,805; sodium nitrate, 26,800; and common salt, 16,657. One may take the following views of these data and of river water generally in so far as they affect the denominator of the fraction:—

The Nitrate.—The succession of events in the process of nitrification is well known to chemists from the genesis of ammonia and carbonic acid to the final production of ammonium nitrate. The theory is further held that when the ammonium nitrate is changed to sodium nitrate it is by interaction with sodium chloride, and that the latter is of marine origin. This last idea is strongly supported by the composition of the *caliche* of the South American nitrate industry. The inference is plainly that the sodium in sodium nitrate is cyclic, and no more available in this calculation of the age of the Earth than Triassic salt. Professor Joly makes no allowance for it, nor indeed any mention of it.

The Common Salt.—I will not reiterate my arguments concerning the part of this compound which is cyclic of short period, as I have sufficiently indicated their nature in my last article. But under this heading the calcium and magnesium carbonates certainly demand attention. These carbonates carry with them on the average probably not less than ·01 per cent. of combined chlorine (p. 447), which, as anyone who knows anything of analysis will

understand, is included under the head of chlorides, and calculated into common salt would furnish 43 per cent. of the 16,657 tons. It is cyclic of long period, and not available for Professor Joly's calculation.

Fluctuations.—An inverse relation undoubtedly exists between the soluble contents of a river (including, of course, sodium compounds) and the amount of water in it in Summer and Winter. In all the great rivers subject to flood the variation must be enormous; in the case of the Nile it amounts to 400 per cent. As far as I can learn, these fluctuations have not been taken into account.

Coming once more to the numerator: Mysteries hang over it. The composition of the sea is not what one would expect with the precise conditions of solvent denudation required by Professor Joly's speculations. For instance, one looks for huge proportions of nitrate in it; sea analyses show practically none. Again, the chlorine in it multiplied by a known factor is a measure of its sodium contents, but the same factor does not apply to average river water. These are not matters of opinion but of fact. What becomes, then, of Dr. Joly's "constancy in the *nature* and *rate* of solvent actions going on over the land surfaces" (Trans. Roy. Soc. Dublin, ser. II, vol. vii, p. 24)?

Too much space and time would be required for me to deal with the second half of Professor Joly's November article. I may, however, be permitted to observe that he appears to me to tilt at an irrefragable law of solution, and then only saves his lance from being utterly shattered by an adroit swerve.

NOTICES OF MEMOIRS.

I.—Note on the Cambrian Fossils of St. François County, Missouri. By Professor C. E. Beecher.[1]

THE small collection of fossils submitted to the writer by F. L. Nason, for identification, is interesting, especially as it determines the geological horizon of an extensive series of limestones, sandstones, conglomerates, etc., in south-eastern Missouri, the age of which has hitherto been somewhat in doubt. Also, since these strata are intimately associated with the lead-bearing rocks of this region, the identification has considerable economic value.

It is stated by Arthur Winslow, in a paper on "The Disseminated Lead Ores of South-Eastern Missouri"[2] (p. 11), that although these rocks are placed in the Lower Silurian "The possibility still remains that there may be a faunal break which will admit of some of the lower strata being classed as Cambrian, though there is nothing in

[1] Reprinted from Silliman's American Journal of Science for November, 1901, pp. 362–366.

[2] Bulletin No. 132 of the United States Geological Survey, 1896.

the stratigraphy to suggest it. This must, therefore, be left to the palæontologists, and owing to the dearth of fossils the problem is not an easy one for them to solve." In volume ix of the Missouri Geological Survey (pt. iv, p. 52, Keyes, 1895) the Fredericktown dolomite (=St. Joseph limestone) is referred to the Upper Cambrian on account of the presence of *Lingulella Lamborni* (Meek), but since this species is peculiar to the horizon, and the genus has a much wider range, this correlation is not established. A general statement is made by Keyes regarding this region (l.c., p. 44) that "No strata younger than the Cambrian are believed to be represented. But few fossils have been found in the rocks of the area, so that the faunal evidence as to geological age is somewhat meagre." The present collection of fossils, made by Mr. Nason, indicates that the entire series is older than the Lower Silurian (Ordovician), and that at least the upper portion probably belongs to the Upper Cambrian. All but one species of the fossils were obtained from the lower members of the Potosi limestones, and since this is the topmost formation of this region its correlation is of the first importance. The fossils occur abundantly in the limestone and conglomerate beds, and more sparsely in the sandstones. They consist chiefly of fragments of trilobites, with a few brachiopods and other forms. Lithologically, there is a very close resemblance between these fossil-bearing beds and those of a similar horizon in the Black Hills of South Dakota. Limestones, limestone conglomerates, and sandstones of the same appearance are found in both sections. Faunally, there is a suggestion of affinity with the Potsdam fauna of Wisconsin and Texas. A careful comparison, however, reveals that these resemblances are more general than specific, and that the species seem to be distinct. Nevertheless, the facies of this fauna seems to indicate Upper Cambrian, though further studies with additional material may show it to belong to the middle member.

Owing to the small number of specimens in the present collection, the number of species is necessarily limited. It will doubtless be considerably increased by future collections. Among the trilobites the genera *Ptychoparia, Ptychaspis, Chariocephalus,* and *Crepicephalus* are more or less clearly identifiable. A species of *Chariocephalus* closely agrees with the *C. onustus* of Whitfield.

The species of brachiopods seem to be fairly abundant, especially an orthoid shell resembling in some respects *Billingsella.* It occurs in the shaly partings between the layers of limestone. A species of *Acrotreta* and *Lingulella* are common both in the limestones and arenaceous beds.

Hyolithes primordialis, Hall, and a small species of *Platyceras* also occur in the limestones, together with segments of cystidean or crinoidal columns.

Abundant remains of a linguloid shell are found on the lower, or La Motte, sandstones constituting the basal member of the clastic rocks of the section. Making allowances for different conditions of preservation, this species may be identified with the *Lingulella Lamborni* of Meek, which occurs in some green shales of the same

age in Madison County, a little further south. In the absence of other evidence the diagnostic value of this brachiopod is very slight, and it is impossible to say whether the Bonne Terre, or St. Joseph, limestones and the La Motte sandstones represent Lower Cambrian terranes or whether they with the Potosi all belong to the Middle or Upper Cambrian.

The important point of this correlation is that, upon palæontological evidence which has hitherto been largely wanting, an extensive area and thickness of sedimentary rocks are definitely placed in the Cambrian.

II.—Discovery of Eurypterid Remains in the Cambrian of Missouri. With an Illustration. By Prof. C. E. Beecher.

THE wonderful development of Merostomes in various parts of the world at about the close of the Silurian has long been recognized, and the suddenness of their appearance out of an apparently clear Palæozoic sky has been a matter of considerable speculation. Almost at the same instant of time there appeared on the geologic horizon a marvellous assemblage of these ancient arthropods. A very few scattering forerunners are known from older rocks, but most of them are small and strange creatures, little resembling the characteristic *Eurypterus* and *Pterygotus* of the Upper Silurian, and in fact belonging to other orders than the Merostomata.

In North America the known genera and species of the order Eurypterida belong almost exclusively to the Waterlime group (Rondout) above the Salina beds. Dr. John M. Clarke[1] has recently announced the discovery, by Mr. C. J. Sarle, of a new Eurypterid fauna at the base of the Salina, which carries this peculiar biologic facies one comparatively brief stage further back. Evidences of still older forms are very meagre. A single species of *Eurypterus* (*E. prominens*, Hall) is referred to the Clinton beds of the Silurian with considerable doubt. The next indication of a greater antiquity of this order consists of a fragment of an abdominal segment and a single jointed limb, from the Utica slate of New York, described by C. D. Walcott[2] as *Echinognathus Clevelandi*.

It is therefore of considerable interest and importance that a new and much older horizon for the Eurypterida can now be chronicled.

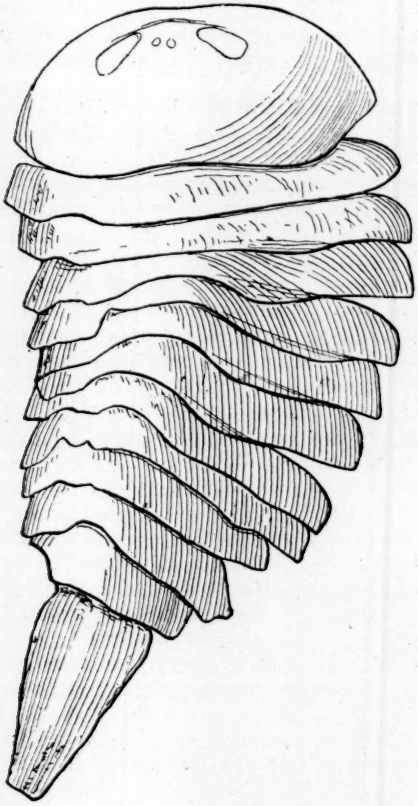
Mr. Arthur Thacher, President of the Central Lead Company of Missouri, formerly a professor in Washington University, found a nearly entire specimen of a new Eurypterid in the Potosi limestone of St. François County, and through his generosity and the kindly interest of Mr. Frank L. Nason the specimen was transmitted to the Yale University Museum. Owing to the supposed scarcity of fossils in the Potosi and St. Joseph terranes of Missouri, their

[1] Notes on Paleozoic Crustaceans. N.Y. State Museum, Report of the State Paleontologist for 1900. 1901.

[2] Description of a new genus of the Order Eurypterida from the Utica Slate. Silliman's Journal (3), vol. xxiii, 1882.

correlation was long a matter of uncertainty, until Mr. Nason described certain horizons bearing an abundant and characteristic Cambrian fauna.

The specimen here described at once suggests the familiar and well-known genus *Eurypterus*, and only when its characters are studied in connection with its geological occurrence is it apparent that its differences are of sufficient importance to warrant its generic separation. The specimen represents nearly the entire dorsal test of the animal, and consists of the cephalothorax with the abdominal segments, including the telson or tail-spine.



Strabops Thacheri, Beecher.—Dorsal aspect of type-specimen, ½. Potosi Limestone (Cambrian): St. François County, Missouri. Original in Yale University Museum.

The cephalothorax is comparatively shorter and wider than in *Eurypterus*, the eyes are further forward, nearer together, and more oblique, and besides the telson but eleven abdominal somites can be determined on the dorsal side, instead of twelve as in *Eurypterus*.

These differences are considered as indicative of a new genus, and it is proposed to recognize this type under the name *Strabops*, nov. gen., with *Strabops Thacheri*, n.sp., as the type species. The generic name is in allusion to the inward turning or squinting of the eyes (*σταβός* 'squinting' and *ὄψις* 'face').

Doubtless many generic differences will appear when the appendages of this type are obtained. The differences in the characters available for comparison are quite as great as between *Eurypterus* and *Dolichopterus*, *Stylonurus*, *Anthraconectes*, or *Eusarcus*. This, taken with the fact that practically all the Cambrian genera, especially the more highly organized types, became extinct long before the Upper Silurian, lend support to the conclusion that *Strabops* is generically distinct from any hitherto known form.

STRABOPS THACHERI, gen. et sp. nov.

Body broadly ovate in general outline exclusive of the telson, slightly convex in the specimen, though probably quite arched both transversely and longitudinally in life, as indicated by the outline of the separate segments.

Cephalothorax short and broad, length less than one-half the width, anterior and lateral margins regularly rounded, posterior margin gently curved in the middle and turning obliquely forward toward the genal extremities, which are obtusely angular.

Eyes medium-sized, ovate, narrow ends pointing obliquely inward, situated in the middle of the anterior half of the cephalothorax, distant about the length of one eye, connected anteriorly by a distinct arched line or fold. The eye tubercles are mostly exfoliated, and their convexity and surface cannot be determined. *Ocelli* indicated by two spots midway between the eyes.

Abdomen. The dorsal side shows eleven segments exclusive of the telson. The axis in the specimen is slightly convex, and slopes off into the nearly flat pleural region without any line of demarkation. The greatest width is across the third segment. The extremities of the segments are rounded anteriorly and on the sides, and terminate behind as a simple angulation. The first six segments are quite uniform in length, while the three following are somewhat shorter, and the last two are a little longer.

Telson a broad flat spine, obtusely elevated along the middle.

Surface smooth, with an indication of a row of minute crenulations or scale-like markings near the posterior edge of each segment.

Dimensions.—Greatest length of specimen 110 mm., length exclusive of telson 82 mm.; greatest width, allowing for compression on left side, 60 mm.; length of cephalothorax 20 mm., width 49 mm.; greatest width of telson 17 mm.

Formation and locality.—From the lower members of the Potosi limestone, Flat River, St. François County, Missouri.

The only known genus of merostomes besides *Strabops* occurring in the Cambrian is *Aglaspis*, Hall, represented by two species (*A. Barrandi* and *E. Eatoni*, Whitf.). But since *Aglaspis* belongs

to the order Synxiphosura, it leaves *Strabops* as the present sole representative of the Eurypterida.[1]

III.—On the Anatomy of *Todea*, with an Account of the Geological History of Osmundaceæ. By A. C. Seward, F.R.S., and Miss Sybille O. Ford.[2]

THE anatomical structure of the genus *Osmunda* has been dealt with by several writers, and more particularly by Zanetti in an able paper published in the *Botanische Zeitung* for 1895, but the other genus of the Osmundaceæ has not received equal attention at the hands of anatomists. Our work, which was undertaken with a view to discover in what respects *Todea* differs from *Osmunda*, includes the examination of *Todea barbara* and *T. superba*, as well as the investigation of series of microtome sections of young plants. The family Osmundaceæ is usually regarded as to some extent intermediate between the Eusporangiate and Leptosporangiate ferns, and in many respects the two genera *Osmunda* and *Todea* are of interest in regard to the phylogeny of the various divisions of the Filicinæ.

The stem of *Todea barbara* is traversed by a single stele composed of xylem groups surrounding a central pith and separated from one another by medullary rays: these groups vary considerably in shape and number at different levels. There may be as few as two or as many as eight xylem strands in one transverse section of the stem, while in *Osmunda regalis* the number is considerably greater. The xylem strands are surrounded by parenchyma, and the sieve-tube zone occupies the same position as in *Osmunda*. This zone, which is continuous in *O. regalis*, is occasionally discontinuous in *Todea* opposite some of the xylem strands. The comparatively large sieve-tubes occur in triangular patches at the outer end of each medullary ray. A characteristic band of tangentially elongated elements succeeds the sieve-tube zone, and this is followed externally by a parenchymatous band, the outermost layer of which constitutes the endodermis. The paper deals with the phyllotaxis of *Todea barbara*, the origin of the leaf-traces, and the gradual alteration in structure which the collateral leaf-trace undergoes as it passes out from the stele of the stem as a horseshoe-shaped strand with one protoxylem group, and gradually assumes the form of the broadly U-shaped concentric stele of the petiole with its numerous protoxylem groups. The anatomy of 'seedling' plants of *Todea* is found to agree with that of *Osmunda regalis* plantlets as described by Leclerc du Sablon. As bearing on the questions of relative

[1] Although *Aglaspis* was compared with *Limulus* by Professor Hall, and its affinities were distinctly stated as with the Merostomata, yet most subsequent writers have overlooked its true relationships and have included it in their lists of trilobite genera. The family named Aglaspidæ was first employed in 1877 by S. A. Miller in "The American Palæozoic Fossils," p. 208, and the restoration of the family to the Merostomata was first made by the writer in a paper entitled "Outline of a Natural Classification of the Trilobites" (Silliman's Journal (4), vol. iii, p. 182, 1897).

[2] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

antiquity and phylogeny of the members of the Filices, we have endeavoured to give an account of the geological history of the Osmundaceæ.

IV.—Plants and Coleoptera from a Deposit of Pleistocene Age at Wolvercote, Oxfordshire. By A. M. Bell, M.A., F.G.S.[1]

PLANT remains of Pleistocene time are of great rarity in England. The two most important series which have been described are from Hoxne, in Suffolk, obtained by Mr. Clement Reid, F.R.S., and Mr. H. N. Ridley (Geol. Mag., 1888, p. 441), and from North London by Mr. Worthington G. Smith.

There is in these remains a singular difference. Of twenty-eight plants obtained at Hoxne three are Arctic (*Salix polaris* and *myrsinites*, *Betula nana*); seventeen range to the Arctic Circle. At Stoke Newington, on the contrary, Mr. W. J. Smith obtained the elm, the chestnut, clematis, and perhaps the vine. Only three out of eleven plants reach the Arctic Circle. The pine, the alder, birch, and yew, with the royal fern, were more in harmony with the present and the past floras. In the author's opinion the Stoke Newington flora represents a much later age of Pleistocene time than the Hoxne flora. The conditions were continental, and the flora of the south was gaining, while the Arctic flora was disappearing.

The plants as yet identified, by the kindness of Mr. Clement Reid, from Wolvercote resemble those found at Stoke Newington more than those at Hoxne. This is in harmony with the writer's view that the Wolvercote deposit is of late Pleistocene age, nearer to the Stoke Newington than to the Hoxne deposit.

Eighteen plants obtained by the author are given. All of them are found in Oxfordshire to-day. Eight only have an extension to the Arctic Circle. Four mosses have been obtained, one of which is certainly recent. A considerable number of the wing-cases of beetles have also been found. These are difficult to identify, but the genus of one, remarkable by its rows of hairs, has been named by Mr. Waterhouse, of the Natural History Department of the British Museum. Only one of the genus is now found in England, and that is different from the Wolvercote species. On the other hand the genus is common on the Continent.

These facts, coupled with those from Stoke Newington, tend to the conclusion that in late Pleistocene time the climate of the Thames Valley was more continental than it is at present.

V.—Recent Discoveries in Arran Geology. By William Gunn, of H.M. Geological Survey of Scotland.[1]

(Communicated with the permission of the Director of the Geological Survey.)

IN the last ten years very important additions have been made to our knowledge of the geology of Arran both in the aqueous and in the igneous rocks of the island.

Among the older rocks a series of dark schists and cherts has been discovered in North Glen Sannox. They are probably of Arenig

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

age, though no organic remains have been found in them, are closely related to the rocks of Ballantrae in Ayrshire, and similar beds occur in various places along the Highland border, where they have been described by Messrs. Barrow and Clough. In the Isle of Arran these rocks are intimately connected with the Highland schists.

The Old Red Sandstone of Arran has been found to comprise two subdivisions, and in North Glen Sannox the upper division lies unconformably on the lower. This formation is not confined to the ground north of the String road, as generally supposed, but extends in places three miles to the south of that road, being well developed in the Clachan Glen, where it is much metamorphosed by intrusive igneous rocks. No fossils have been found in the Old Red Sandstone of Arran except *Psilophyton princeps*, specimens of which have been obtained from the lower division in Glen Shurig.

The Carboniferous formation, fine sections of which occur on the shore at Corrie and at Laggan, is now known to occupy but a small portion of the area of the island. Near Brodick Castle and in Glen Shurig its width of outcrop is not much more than 200 yards, and it does not reach the western shore, being overlapped in the interior by unconformable beds of New Red Sandstone. Beds probably of Coal-measure age with characteristic Upper Carboniferous fossils have been recognized at Sliddery Water Head, Corrie, The Cock, and in various other places, but these have no great thickness and contain no seams of coal. They represent apparently the basement beds of the Coal-measures.

The stratified rocks of the southern part of the island, consisting of red sandstones, conglomerates, and marls, have been proved to repose unconformably on the Carboniferous formation, and in places they contain derived pebbles with Carboniferous fossils. All the evidence points to their being of Triassic age, and they may easily be divided into two series, the lower of which probably represents the Bunter Sandstone and the upper the Keuper marls. These Triassic rocks occupy the whole of the coast from Corrie southwards, around the south end of the island, and the west coast up to Machrie Bay, where they appear to lie conformably on the Old Red Sandstone. They also form a small area in the north-eastern part of the island near The Cock.

That still more recent formations once existed in the island, whence they have been removed by denudation, is proved by the presence of fragments of Rhætic, Liassic, and Cretaceous rocks in a large volcanic vent which is probably of Tertiary age. These fragments occur on the western side of the island in the district of Shisken, on the slopes of Ard Bheinn, and they have yielded a considerable number of characteristic fossils which have been examined and determined by Mr. E. T. Newton.

Some of the most important of the discoveries are those connected with the old volcanic rocks of the island. A series of interbedded lavas and tuffs is found in North Glen Sannox associated with the schists and cherts previously mentioned. Like them they are probably of Arenig age, and closely related to similar rocks at

Ballantrae in Ayrshire. Two distinct volcanic platforms have been found in the Old Red Sandstone of the island. One set of basic lavas is intercalated in the lower division on the west side of the island, and another occurs in the upper division of the North Glen Sannox. In addition to the volcanic series previously known in the Lower Carboniferous rocks two others have been discovered in the upper part of the formation. That the island was the seat of volcanic activity in times still more recent is proved by the recognition of a large volcanic vent in the Shiskin district, which must be of post-Cretaceous age, as shown by some of the fragments it includes. From these facts we conclude that the island has been the scene of volcanic action at no less than seven different periods.

Much has also been learned with regard to the distribution and age of the various intrusive igneous rocks. Two masses of a somewhat intermediate character found in Glen Rosie and in Glen Sannox are probably of Old Red Sandstone age, but nearly the whole of the varied igneous rocks of the island must now be assigned to the Tertiary period, not excepting the well-known granite mass of the northern part of the island. The finer granite which occupies the interior of the nucleus has a tortuous boundary. It is clearly intrusive in the coarse granite which surrounds it, but both belong practically to the same period, as they have one and the same system of jointing.

The ring of granite, granophyre, and quartz diorite which surrounds the large volcanic vent was previously little known, and the other numerous and varied intrusive masses, both acid and basic, which occur in the island were but poorly represented on existing maps.

VI.—On the Crystalline Schists of the Southern Highlands; their Physical Structure and Probable Manner of Development. By Peter Macnair.[1]

THE area under notice is defined as that lying immediately to the north-west of the great boundary fault which crosses Scotland from the Firth of Clyde to Stonehaven. An account is then given of the various opinions that have been held concerning the structure of this region since the time of Macculloch up to the present day. The author then proceeds to show that the schist zones traverse this region in roughly parallel bands, and described a series of sections at right angles to the strike of the principal foliation of the area. The following is a summary of the author's conclusions regarding the stratigraphy, physical structure, and the manner of development in this part of the Scottish Highlands:—

1. The sedimentary schists of the Highlands proceeding from the margin inwards may be divided into the following zones:—Lower Argillaceous zone, Lower Arenaceous zone, Loch Tay Limestone zone, Garnetiferous Schist zone, Upper Argillaceous zone, Upper Arenaceous zone. Associated with these are schists of igneous

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

origin. It is probable that these zones are capable of still further subdivision, but this is not attempted as yet.

2. From an examination of the relationships of these different zones, the order as given above appears to be an ascending one, proceeding from the margin inwards, the well-marked zone known as the Loch Tay Limestone forming a sort of datum-line, from which one can recognize the positions of the lower and upper schists.

3. It is supposed that the movements which plicated the rocks of the Highlands were directed from the centre outwards, or from the north-west towards the south-east. This is shown by the fact that where the bedding can be traced the overfolding is generally towards the south-east. Also the foliation, where it has been observed, faces in the same direction.

4. In the eastern part of the region we suppose that the beds have been folded into a series of isoclines facing the south-east, and that foliation has been developed roughly parallel to the axes of the folds in the bedding, thus making the foliation appear to be roughly coincident with the original planes of stratification. At Comrie, in Perthshire, the axes of the isoclines in the bedding are nearly vertical, but with a slight hade towards the north-west. The axes of the isoclines get gradually lower and lower as we proceed towards Loch Tay. In the same way the foliation planes are nearly vertical along the frontier, but get flatter and flatter as we proceed northwards.

5. In tracing these rocks towards the south-west an increasing crumpling and folding of the foliation planes, accompanied by more intense metamorphism, is seen to take place: this is made evident in approaching the shores of Loch Katrine and Loch Lomond, but it seems to have reached its maximum in Cowal.

6. In Cowal, along the Firth of Clyde, the position of the foliation planes has been reversed, now dipping towards the south-east. Between the Firth of Clyde and Loch Fyne the foliation planes have been much crumpled, and still later divisional planes have been developed in them, this being a region of the most intense metamorphism.

VII.—The Source of Warp in the Humber. By W. H. Wheeler, M.Inst. C.E.[1]

IT has frequently been stated that the mud or warp in suspension in the Humber is derived from the erosion of the cliffs on the Yorkshire coast, and the object of the paper is to show that it is physically impossible for the detritus eroded from those cliffs to be carried into the Humber, and that the material in suspension in the water is derived from detritus washed off the land drained by the Humber and its tributaries or eroded from their banks. The drainage basin of the Humber covers 10,500 square miles, and embraces strata of various kinds of rocks, including estuarine deposits, glacial drifts, chalk, sandstone, and oolites.

The water in the zone extending around the junction of the Trent

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

and the Ouse with the Humber, extending over a length of thirty-five miles, is very highly charged with solid matter in suspension, the maximum quantity being attained in the Summer, when the downward flow of the fresh water is at a minimum, the quantity then in suspension amounting to as much as 2,240 grains, or nearly the third in a cubic foot of water. Above and below this zone the quantity diminishes to 262 grains up the river Trent and 202 grains near the Albert Dock at Hull, while off Spurn, at the entrance to the river, there is no mud in suspension, but only a few grains of clean sand. The floor of the North Sea at the entrance is covered with clean sand and shells, the beach up to Grimsby also being covered with sand.

The solid matter in suspension is derived from the detritus washed off the land and poured into the river when freshets occur, or from the erosion of the banks of the river and its tributaries. The greater quantity that prevails in the more turbid zone is due to the material being kept in a state of oscillation by the ebb and flow of the tides when the quantity of fresh water flowing down is not sufficient to carry it out to sea.

The average quantity of solid matter contained in thirteen other English rivers when in flood is 200 grains in a cubic foot. The average rainfall within the watershed of the Humber is 29·60 inches, of which 10 inches may be taken as the quantity due to such rains as produce freshets. With these figures the normal total quantity of solid matter placed in suspension in floods may be put at three million tons in a year. A portion of this is carried out to sea in heavy freshets, and the rest remains in the river in a state of oscillation.

The tendency in all rivers, whether fresh or tidal, is for material to work downward under the laws of gravity. The same quantity of tidal water that flows into the river has to flow out again, but its capacity for transporting material downwards is reinforced by the discharge of the fresh water.

The flood current in the Humber runs at the rate of four miles an hour, and its duration varies from six hours at Spurn to two and a half at Goole. It may be taken, therefore, that a particle of solid matter entering the Humber at Spurn Point would not be carried by the flood tide more than 20 miles up the river, or 25 miles below the point where the greatest amount of solid matter is held in suspension. On the turn of the tide it would be carried back again. Allowing for the greater time the ebb current is running above the junction of the rivers as compared with the flood, the material carried down on the ebb is 73 per cent. greater than that carried up on the flood.

Taking the length of the Holderness Cliffs as 34 miles, the average height at 12 yards, and the mean annual loss at $2\frac{1}{4}$ yards, the mean quantity falling on the beach is about $1\frac{3}{4}$ million cubic yards a year, of which about 40 per cent. consists of stones, gravel, and coarse sand, leaving less than a million cubic yards to be washed away. The foot of the cliffs is only reached for about four

hours at high-water of springs, that is, by 260 tides in a year, the average quantity of alluvial matter for each tide being 3,728 cubic yards.

The drift of the tidal current towards the Humber lasts 3½ hours, and runs at a velocity of 2½ miles an hour; the greatest distance a particle of solid matter put in suspension at the point of mean distance, 20 miles from the Humber, could be carried southward is 8¾ miles; when this distance is reached the tide would turn and the particle would be carried northward for 16 miles, or 28 miles away from the Humber.

It is, however, quite improbable that a particle of matter placed in suspension at the foot of the cliffs could ever reach the main current going to the Humber. Owing to the Yorkshire coast being in an embayment the main tidal current does not approach nearer the coast than the 6-fathom line, or a mile away from the coast. The current of the flowing tide sets into the embayment towards the coast. Even if a particle from the cliffs could overcome this shoreward set and traverse the water contained in this mile of water in an opposite direction, so as to be brought into the main southerly-going current, the quantity of solid matter brought into suspension would only be sufficient to supply one grain to 14,000 cubic feet of water.

It is evident from the above facts that it is not possible for the detritus from the Yorkshire coast to reach, much more to be carried up, the Humber.

VIII. — The Artesian Water in the State of Queensland, Australia. By R. Logan Jack, LL.D., F.G.S.[1]

THE western interior of Queensland is a vast area of magnificent pastoral country, but is not endowed with a sufficient rainfall. In 1881 the author had reason to suspect that the Cretaceous rocks of the Western Downs afforded conditions favourable for the discovery of artesian water. Subsequently, in 1885, the author (then Government Geologist) and Mr. J. B. Henderson, hydraulic engineer, made a study of the area, and an experimental bore was put down which proved a success.

From Mr. Henderson's annual report for 1899–1900 it appears that up to June, 1900, 185 miles of boring had been made in search of artesian water in the district, and a large proportion of the bores have been successful; and though the artesian water does not fully compensate for the lack of rain, still the bores have already produced an important change in the conditions of life in the interior.

The greater part of the western interior of Queensland is composed of soft strata of Lower Cretaceous age, consisting of clay-shales, limestones, and sandstones. These strata are so disposed that the lower members of the series crop out on the western flanks of the coast range, where not only is the elevation of the surface greater than in the downs to the west, but the rainfall is also comparatively abundant.

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

Along the eastern margin of the Cretaceous area there is a porous sandstone of great thickness, the 'Blythesdale Braystone,' and owing to low dip the outcrop of this permeable stratum occupies a belt from five to twenty-five miles wide; but the Braystone finally disappears beneath the argillaceous and calcareous upper members of the series which forms the surface of the downs to the west. Several rivers disappear while crossing the outcrop of the Braystone, and the water must be carried in it beneath the clay-shales of the downs.

The outcrop of the Braystone is concealed over part of the area by nearly horizontal tablelands of the 'Desert Sandstone,' an upper member of the Cretaceous formation lying unconformably on the lower divisions. It is, however, also of a permeable nature. The author gives an estimate of the water which should penetrate the Braystone, and suggests the probability that much of it finds an outlet under the sea in the Great Australian Bight and the Gulf of Carpentaria.

The artesian water basins are, in fact, broken basins, and the break gives rise to leakage either on land or beneath the sea. In places, therefore, the water rises in a bore, but does not reach the surface owing to the site of the bore being higher than the head of pressure. This is termed 'sub-artesian water,' and the author gives illustrations of both artesian and sub-artesian water in the district in question.

REVIEWS.

LES VARIATIONS DE LONGUEUR DES GLACIERS DANS LES REGIONS ARCTIQUES ET BOREALES. Par CHARLES RABOT. (Extrait des Archives des sciences physiques et naturelles, 1899–1900.) pp. 230. (Geneva and Bale: Georg & Co.)

THIS is the latter part of a treatise of which the former was published in 1897. Since that date much additional information has appeared, of which a summary is given, together with the conclusions to which the author has been led. These are:—(1) Prior to the eighteenth century the glaciers, as proved by documentary evidence in Norway and Iceland, and made highly probable also in Jan Mayen and Spitzbergen, were much less extensive than they are at the present day, and this minimum condition had lasted for centuries. (2) During the eighteenth century, as well as in the earlier years of the nineteenth, a very great extension (*une crue enorme*) occurred, which was general throughout the Northern Hemisphere. In the course of this the glaciers invaded regions which had been free from ice during historic times. Of this, in Greenland, Jan Mayen, Iceland, Norway, and Alaska, in some cases there is documentary proof; in others it is made highly probable by less direct evidence. (3) The remainder of the nineteenth century has been a period of uncertain movements. In some places a considerable advance has been followed by a slight retreat; in others the latter set in after a pause at the maximum which had been reached in the earlier years. At the present day the Greenland

glaciers appear to be stationary at a maximum. In Iceland almost all the glaciers are now retreating, though not to any great extent, and in some of them the previous advance continued till about the year 1880. From Spitzbergen the evidence is defective; so far as it goes some glaciers appear to be advancing, others retreating. In Norway the ice reached a maximum at the beginning of the century, and since then there has been a slow retreat, interrupted by slight advances. In none of these regions has there been a diminution comparable with that which has been observed in the Alps during the last half-century. M. Rabot has drawn up a table to show the advances of the glaciers for Greenland, Iceland, Jan Mayen, Spitzbergen, Scandinavia (north and south), and the Alps. Though the information is not equally full and precise in all cases, it suffices to show that while the movements of the glaciers in the northern region exhibit a general correspondence, they afford signs of a local individuality, and those of the Alpine glaciers appear to be in most cases independent. The results from the northern region are then used by M. Rabot to test the three laws of the variation of glaciers which were tentatively advanced by Professor Forel. (*a*) The law of periodicity. In the north this apparently does not hold good, the duration of the advances and retreats being irregular. (*b*) Law of simultaneousness. This holds good. (*c*) Law of variation of volume; namely, that any change affects the length, breadth, and thickness of the glacier. This apparently is not valid in the north, for there the end of a glacier may be stationary or even advancing, while its thickness higher up is diminishing. For this apparent anomaly the author offers an explanation. Lastly, he discusses the question whether the results of the more minute observations which have been carried on in the Alps during the last twenty years establish a relation between the variations of the climate and the length of the glacier; such a relation appears to be suggested, but more evidence is needed before it can be regarded as established.

The rule "Always verify your references" holds good, as commonly, in M. Rabot's book, for names are often misspelt. We leave Germans to deal with Pettermanus, but object to Professor Garwood being persistently transformed into Garnwood. This, however, is a superficial blemish. The memoir itself embodies a mass of information, accumulated by patient and laborious study, and cannot fail to be very valuable for purposes of reference to all who take an interest in glacial questions. T. G. Bonney.

REPORTS AND PROCEEDINGS.

I.—Geological Society of London.

November 6th, 1901.—J. J. H. Teall, Esq., M.A., V.P.R.S., President, in the Chair. The following communications were read :—

1. "Note on a Submerged and Glaciated Rock-Valley recently exposed to view in Caermarthenshire." By Thomas Codrington, Esq., M.Inst. C.E., F.G.S.

This valley was brought to light in building a bridge across the River Towy at Drysllwyn, 9 miles from Caermarthen, to which the tide now flows. At the bridge the valley is narrowed to about half a mile. Near the water-edge the rock sloped down gradually to 23 feet below summer water-level, and was glaciated in large furrows a foot or more across, and striated blocks of grit rested upon it. About 60 feet farther out into the river, rock was not met with till depths of from 34 to 42 feet below summer level were reached, and the rock-surface was found to be sloping towards the south at an angle of from 28° to 18° with a vertical line; it was followed down to between 45 and 56 feet below summer water-level. Scratched stones were again met with in the clay near the rock. The glaciated surface on the northern bank is only 25 feet above sea-level; and the rock-surface is sloping down at a precipitous angle at 8 feet below sea-level at a distance of 18 miles from the mouth of the river.

2. "On the Clarke Collection of Fossil Plants from New South Wales." By Edward Alexander Newell Arber, Esq., B.A. (Communicated by Professor T. McKenny Hughes, B.A., F.R.S., F.G.S.)

This collection, numbering nearly 2,600 specimens of all kinds, including some 80 fossil plant-remains, was presented to the Woodwardian Museum, Cambridge, in November, 1844.

The following is the stratigraphical succession in New South Wales:—

4. Wianamatta and Hawkesbury Beds.
3. Newcastle Beds.
2. Marine or Muree Beds. { *c*. Upper Marine Beds. *b*. Lower Coal-measures. *a*. Lower Marine Beds.
1. *Lepidodendron*-beds (Arowa, etc.).

Four species from the Wianamatta Series are described, fourteen species (including one new one) from the Newcastle Series, and two from the Arowa Beds. Of the twelve new types described by McCoy,[1] five (namely, *Odontopteris microphylla*, *Sphenopteris plumosa*, *Glossopteris linearis*, *Phyllotheca ramosa*, and *Ph. Hookeri*) are no longer considered as such. One new type has been added.

The age of the beds is then discussed. Such evidence as the few plants in the Clarke Collection afford supports Feistmantel's conclusion that the Wianamatta Beds are of Triassic age. *Thinnfeldia odontopteroides* occurs in Rhætic beds in South America, and the identification of Rattee's *Salisburia palmata* with the American *Baiera multifida*, and a comparison with the Rhætic *Baiera Steinmanni* of Chile, is a new point in favour of this conclusion. The plants also support Feistmantel's opinion that the Newcastle Beds are equivalent to the Permian of Europe. The exact horizon and age of the Arowa Beds must for the present remain doubtful.

3. "On an Altered Siliceous Sinter from Builth (Brecknockshire)." By Frank Rutley, Esq., F.G.S.

[1] Ann. Mag. Nat. Hist., 1847, vol. xx.

A rock-specimen, given to the author many years ago by the late H. W. Bristow, forms the main subject of this paper. It shows no trace of original sand-grains; it is compact, and with a fracture platy to conchoidal; small splinters of it can be fused on their edges to a white, frothy glass. Under the microscope the rock is decidedly tufaceous, containing small fragments chiefly of pumice, less often of crystals which are apparently epidote. In the slides of this rock and in some of the siliceous sinters from New Zealand used for comparison, there are small patches of a brown substance which may possibly be of organic origin; in connection with it, Professor Weed's discovery of algous growths in some of the New Zealand sinters is mentioned. A specimen of hard breccia, also from the vicinity of Builth, is described. The cement of this rock is also possibly siliceous sinter, as well as some of the fragments, which latter show faint evidence of the inclusion of little shreds of pumice.

II.—Manchester Literary and Philosophical Society.

October 15th, 1901.—Mr. Charles Bailey, President, in the Chair.

Mr. R. D. Darbishire, F.S.A., exhibited a large collection of the Eolithic implements of the Kentish plateau, and illustrated with map and section the outline of the denudation of the valley of the Weald, leaving a drift-deposit on the remaining Chalk of the north and south escarpments.

In the process many levels of river-gravels had been fixed, and partly occupied by stone implements of successive ages, mostly much mixed up in the redeposition of the gravels by succeeding movements. He described the general facies of the so-called Palæolithic implements from river deposits in France and England, and their peculiar modes of manufacture by 'chipping' or flaking, and shapes; and confessed inability to determine the uses of such tools or any characteristics of the men who made them. They were fossil indications of man with mind, skill, and purpose, and that was all. He then referred to the late Sir Joseph Prestwich's announcement of Mr. B. Harrison's great discovery of stone implements in the drift covering the remaining chalk plateau, quoted important adhesions, and referred to the expressions of scepticism by Sir J. Evans, Professor Boyd Dawkins, Sir H. H. Howorth, and others.

Exhibiting a very complete and well-arranged series of the plateau remains, Mr. Darbishire, after claiming large personal familiarity with stone implements, proceeded to vindicate the primeval and distinctive character of the same by reference to:—(1) The peculiar character of (*a*) the material used, and (*b*) the uniform and extreme 'patination' of most specimens. (2) The peculiar shapes of the same, showing several separate designs (*c*) in lateral curves (like bites out of a cake), sometimes duplicated with a point left between; (*d*) in instruments with bold lateral curves on each side of a strong, sometimes sharp, sometimes obtuse point; (*e*) in flat flints, with chipped edges more or less all round; and (*f*) in repudiation of a vague dismissal of the remains in question as 'wastrels.'

(3) The peculiar and original fashion of chipping the flint *perpendicularly through the thickness* so as to remove the natural edge (sharp and rough) of the stone, and the general absence of work on the sides of the tool. (4) The collective facies of the mass, unembarrassed by admixture of forms known as Palæolithic. And lastly to (5) a very decided declaration that after many years' study of stone implements from various countries and ages, he had never seen an eolith amongst palæoliths, or a palæolith amongst eoliths.

In conclusion, he declared his unhesitating concurrence with those more learned and skilful observers who believed that in the so-called Eolithic remains Mr. Harrison had revealed the fossil indications of the mind and purpose of a race of men long anterior to that of the Palæolithic record, and confirmed a precedent geological era for the habitation in this country of Man, actually qualified by invention, design, skill, purpose, and perseverance—still the fundamental characteristics of the race—which with the great development and inheritance of civilization, the arts, and literature, is now possessing the earth.

CORRESPONDENCE.

FAXE OR FAXOE.

SIR,—I recently saw it stated in the GEOLOGICAL MAGAZINE that Faxe is the correct name of the well-known locality for fossils in Zealand, and that the name Faxoe used by Darwin and others is impossible, as the place is not an island. This is not conclusive. May not the place have formerly been an island, and may not Faxe be a modern corruption of an older name Faxoe? It is well known to philologists, and to all who have paid any attention to place-names, that there are many places which are proved by their names to have once been islands, though they are no longer so. The late Isaac Taylor, in his interesting book, "Words and Places," mentions several such names in the Valley of the Thames and in the Eastern Counties, as well as elsewhere. J. R. DAKYNS.

SNOWDON VIEW, GWYNANT, BEDDGELERT.

FOSSILS WITH GARNETS.

SIR,—*Verbum sapientibus* contains in itself no proposition: it may equally be either *sat sap.* or sat upon *insip.*; in this style, "Words are worth nothing, therefore take mine." But certainly, in a case like the present, where statements of opposite import are both alike quotations from the "traditions of the elders," the old motto of the Royal Society, for those in a position to adopt it, *Nullius per verba*, is the best VERBUM SAP.

THE CIRCULATION OF SALT.

SIR,—In connection with recent questions concerning the circulation of salt I would like to call attention to a curious phenomenon described by Messrs. F. W. and W. O. Crosby in the *Technology Quarterly* (U.S.A.), vol. ix, No. 1, March, 1896. I refer to the

"*Sea mills of Cephalonia*" (Greece). "The mills are driven by a current of sea-water which flows into the land for about fifty yards through an artificial channel, finally disappearing amid clefts and fissures in the limestone rock" (Baedeker). "The boundaries of this influx have never been definitely determined, but it certainly extends along the coast for nearly half a mile" (loc. cit.). Messrs. Crosby estimate the daily consumption of sea-water at 6,000,000 cubic feet. H. E. Strickland has also described these sea-mills (Proc. Geol. Soc., xi, pp. 220, 221).

A. K. Coomara-Swamy.

Worplesdon.

SALTER'S UNDESCRIBED SPECIES.

Sir,—In my first paper on some of Salter's Undescribed Species (Geol. Mag., 1900, Dec. IV, Vol. VII, p. 303, Pl. XII) there is an unaccountable omission, which has only within the last few days been brought to my notice. There is an absence of any reference to the specimen represented in Fig. 7 on the accompanying plate. In what manner the oversight occurred I am unable to discover, as a description was ready for publication with the rest of the paper. The specimen figured, which is referable to the species *Niobe solvensis* (Hicks), is of not a little interest, because it is the one mentioned by Salter (Cat. Camb. Sil. Foss. Woodw. Mus., 1873, p. 23, *a* 469) under the name *Asaphus Menapiæ*. The following description is given by him (*loc. cit.*): "*Asaphus Menapiæ*, Hicks (undescribed). A large species with smooth tail-piece." It comes from the Tremadoc rocks of Ramsey Island, and was presented to the Woodwardian Museum by Dr. Hicks. It occurs on the same piece of rock as the type-specimens of *Calymene vexata* (Salter) (? = *Neseuretus recurvatus*, Hicks) and *Calymene ultima* (Salter) (? = *Neseuretus quadratus*, Hicks), which I have described and figured in the paper above mentioned. The piece of rock bears Salter's label with these names; also a later label in Tawney's handwriting, with the inscription "Salter's MSS. names not adopted exactly by Hicks when he described the fossils." This remark is borne out also by the fact that this pygidium of *Asaphus Menapiæ* does not agree with that of *Niobe menapiensis* (Hicks), as figured and described by Hicks (Q.J.G.S., vol. xxix, 1873, p. 46, pl. iv, figs. 1–9), but with that of *Niobe solvensis* (Hicks), described and illustrated at the same time. Hicks makes here no mention of the name *Asaphus Menapiæ*, and was apparently ignorant of its retention in the Cambridge Catalogue, which was then on the eve of being published. The specimen of *A. Menapiæ* is a slightly distorted internal cast of the pygidium, measuring 26 mm. wide and 16 mm. long, and it agrees in all its visible characters with Hicks' *Niobe solvensis*.

In my paper there is also an obvious misprint in the numbering of the figures on the plate (Pl. XII). *Neseuretus quadratus* is represented by Fig. 6, not by Fig. 5, which represents *Neseuretus*, sp.

F. R. Cowper Reed.

Woodwardian Museum, Cambridge.

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